COMPAQ

Compaq ProLiant Clusters HA/F100 and HA/F200

Administrator Guide

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About This Guide

This guide is designed to be used as step-by-step instructions for installation and as a reference for operation, troubleshooting, and future upgrades of the cluster server.

This guide provides information about the installation, configuration, and implementation of the Compaq ProLiant Cluster Models HA/F100 and HA/F200.

Audience

The primary audience of this guide consists of MIS professionals whose jobs include designing, installing, configuring, and maintaining Compaq ProLiant clusters.

This guide contains information that may be used by network administrators, installation technicians, systems integrators, and other technical personnel in the enterprise environment for the purpose of cluster installation, implementation, and maintenance.

IMPORTANT: This guide contains installation, configuration, and maintenance information that can be valuable for a variety of users. If you are installing the Compaq ProLiant Cluster HA/F100 or HA/F200 but will not be administering the cluster on a daily basis, please make this guide available for the person who will be responsible for the clustered servers when you have completed the installation.

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Scope

Some clustering topics are mentioned, but not detailed, in this guide. Be sure to obtain other Compaq documents that offer additional guidance. This guide does not describe how to install and configure specific applications on a cluster. However, several Compaq TechNotes provide this information for industry-leading application.

This guide is designed to assist you in attaining the following objectives:

- Planning and designing the Compaq ProLiant Cluster HA/F100 or HA/F200 configuration to meet your business needs
- Installing and configuring the Compaq ProLiant Cluster HA/F100 or HA/F200 hardware and software
- Using Compaq Insight Manager and Compaq Insight Manager XE, Compaq Intelligent Cluster Administrator, and Compaq Redundancy Manager to manage your Compaq ProLiant Cluster HA/F100 or HA/F200

The contents of this guide are outlined below:

- Chapter 1, "Architecture of the Compaq ProLiant Clusters HA/F100 and HA/F200," describes the hardware and software components of the Compaq ProLiant Cluster HA/F100 and HA/F200.
- Chapter 2, "Designing the Compaq ProLiant Clusters HA/F100 and HA/F200," outlines a step-by-step approach to planning and designing a cluster configuration that meets your business needs. Included are several cluster planning worksheets that help in documenting information necesssary to configure your clustering solution.
- Chapter 3 "Setting Up the Compaq ProLiant Clusters HA/F100 and HA/F200," outlines the steps you will take to install and configure the Compaq ProLiant Clusters HA/F100 and HA/F200.
- Chapter 4, "Upgrading the HA/F100 to an HA/F200," illustrates procedures for upgrading the Compaq ProLiant Cluster HA/F100 to a HA/F200.
- Chapter 5, "Managing the Compaq ProLiant Cluster HA/F100 and HA/F200," includes techniques for managing and maintaining the Compaq ProLiant Clusters HA/F100 and HA/F200.
- Chapter 6, "Troubleshooting the Compaq ProLiant Clusters HA/F100 and HA/F200," contains high-level troubleshooting information for the Compaq ProLiant Clusters HA/F100 and HA/F200.

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- Appendix A, "Cluster Configuration Worksheets," contains blank worksheets to copy and use as directed in the cluster design and the installation steps outlined in chapters 2, 3, and 4.
- Appendix B, "Using Compaq Redundancy Manager in a Single-Server Environment," explains how to implement Redundancy Manager in a nonclustered server environment.
- Appendix C, "Software and Firmware Versions," provides software and firmware version levels that are required for your Compaq ProLiant Cluster.
- "Glossary," provides definitions for terms used throughout the guide.

Text Conventions

This document uses the following conventions to distinguish elements of text:

Keys	Keys appear in boldface. A plus sign (+) between two keys indicates that they should be pressed simultaneously.
USER INPUT	User input appears in a different typeface and in uppercase.
FILENAMES	File names appear in uppercase italics.
Menu Options, Command Names, Dialog Box Names	These elements appear with initial capital letters.
COMMANDS, DIRECTORY NAMES, and DRIVE NAMES	These elements appear in uppercase.
Type	When you are instructed to *type* information, type the information **without** pressing the **Enter** key.
Enter	When you are instructed to *enter* information, type the information and then press the **Enter** key.

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Symbols in Text

These symbols may be found in the text of this guide. They have the following meanings.

WARNING: Text set off in this manner indicates that failure to follow directions in the warning could result in bodily harm or loss of life.

CAUTION: Text set off in this manner indicates that failure to follow directions could result in damage to equipment or loss of information.

IMPORTANT: Text set off in this manner presents clarifying information or specific instructions.

NOTE: Text set off in this manner presents commentary, sidelights, or interesting points of information

Getting Help

If you have a problem and have exhausted the information in this guide, you can get further information and other help in the following locations.

Compaq Technical Support

You are entitled to free hardware technical telephone support for your product for as long you own the product. A technical support specialist will help you diagnose the problem or guide you to the next step in the warranty process.

In North America, call the Compaq Technical Phone Support Center at 1-800-OK-COMPAQ[1]. This service is available 24 hours a day, 7 days a week.

Outside North America, call the nearest Compaq Technical Support Phone Center. Telephone numbers for worldwide Technical Support Centers are listed on the Compaq website. Access the Compaq website by logging on to the Internet:

http://www.compaq.com

[1] For continuous quality improvement, calls may be recorded or monitored.

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Be sure to have the following information available before you call Compaq:

- Technical support registration number (if applicable)
- Product serial numbers
- Product model name and number
- Applicable error messages
- Add-on boards or hardware
- Third-party hardware or software
- Operating system type and revision level
- Detailed, specific questions

For additional information, refer to documentation related to specific hardware and software components of the Compaq ProLiant Clusters HA/F100 and HA/F200, including, but not limited to, the following:

- Documentation related to the ProLiant servers you are clustering (for example, manuals, posters, and performance and tuning guides)
- Compaq RA4000 Array documentation
- Microsoft NT Server 4.0/Enterprise Edition Administrator's Guide

Compaq Website

The Compaq website has information on this product as well as the latest drivers and Flash ROM images. You can access the Compaq website by logging on to the Internet:

http://www.compaq.com

Compaq Authorized Reseller

For the name of your nearest Compaq authorized reseller:

- In the United States, call 1-800-345-1518.
- In Canada, call 1-800-263-5868.
- Elsewhere, see the Compaq website for locations and telephone numbers.

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Chapter 1

Architecture of the Compaq ProLiant Clusters HA/F100 and HA/F200

Overview of Compaq ProLiant Clusters HA/F100 and HA/F200 Components

A cluster is a loosely coupled collection of servers and storage that acts as a single system, presents a single-system image to clients, provides protection against system failures, and provides configuration options for load balancing.

Clustering is an established technology that may provide one or more of the following benefits:

- Availability
- Scalability
- Manageability
- Investment protection
- Operational efficiency

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Compaq ProLiant Clusters HA/F100 and HA/F200 platforms are composed of the following.

Hardware:

- Compaq ProLiant servers
- Compaq StorageWorks RAID Array 4000 Storage System (formerly Compaq Fibre Channel Storage System)
  - Compaq StorageWorks RAID Array 4000
  - Compaq StorageWorks Fibre Channel Storage Hub (7- or 12-port)
  - Compaq StorageWorks Fibre Channel Host Adapter
  - Compaq StorageWorks RA4000 Controller
  - Gigabit Interface Converter-Shortwave (GBIC-SW) modules
- Cables
- Cluster interconnect adapters

Software:

- Microsoft Windows NT Server 4.0 Enterprise Edition
- Compaq SmartStart and Support Software CD
- Compaq Support Software Diskette for Windows NT (NT SSD)
- Compaq Redundancy Manager (Fibre Channel)
- Compaq Cluster Verification Utility
- Compaq Insight Manager
- Compaq Insight Manager XE
- Compaq Intelligent Cluster Administrator

This chapter discusses the role each of these products plays in bringing a complete clustering solution to your computing environment.

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Compaq ProLiant Cluster HA/F100

The Compaq ProLiant Cluster HA/F100 includes these hardware solution components:

- 2 Compaq ProLiant servers
- 1 or more Compaq StorageWorks RAID Array 4000s
- 1 Compaq StorageWorks Fibre Channel Storage Hub (7- or 12-port)
- 1 Compaq StorageWorks RA4000 Controller per RA4000
- 1 Compaq StorageWorks Fibre Channel Host Adapter per server
- Network interface cards (NICs)
- Gigabit Interface Converter-Shortwave (GBIC-SW) modules
- Cables
  - Multi-mode Fibre Channel cable
  - Ethernet crossover cable
  - Network (LAN) cable

The Compaq ProLiant Cluster HA/F100 includes these software solution components:

- Microsoft Windows NT Server 4.0 Enterprise Edition
- Compaq SmartStart and Support Software CD
- Compaq Support Software Diskette for Windows NT (NT SSD)
- Compaq Cluster Verification Utility
- Compaq Insight Manager (optional)
- Compaq Insight Manager XE (optional)
- Compaq Intelligent Cluster Administrator (optional)

NOTE: See Appendix C, "Software and Firmware Versions," for the necessary software version levels for your cluster.

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The following illustration depicts the HA/F100 configuration:

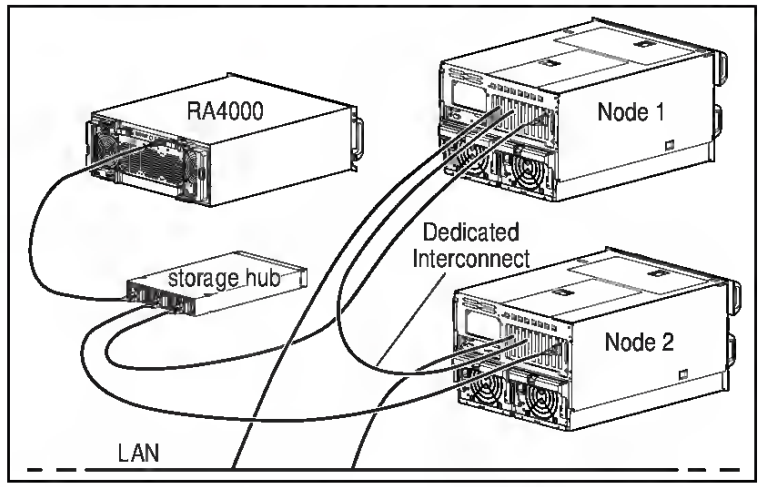

Figure 1-1. Hardware components of the Compaq ProLiant Cluster HA/F100

The Compaq ProLiant Cluster HA/F100 configuration is a cluster with a Compaq StorageWorks RAID Array 4000, a single Compaq StorageWorks Fibre Channel Storage Hub (7- or 12-port), two Compaq ProLiant servers (nodes), a single Compaq StorageWorks Fibre Channel Host Adapter per server, a single Compaq StorageWorks RA4000 Controller per RA4000, and a dedicated interconnect.

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Compaq ProLiant Cluster HA/F200

The Compaq ProLiant Cluster HA/F200 adds Redundancy Manager software and a second, redundant, Fibre Channel Arbitrated Loop (FC-AL) to the HA/F100 configuration. The Redundancy Manager software, in conjunction with redundant fibre channel loops, enhances the high availability features of the HA/F200.

The Compaq ProLiant Cluster HA/F200 includes these hardware solution components:

- 2 Compaq ProLiant servers
- 1 or more Compaq StorageWorks RAID Array 4000s
- 2 Compaq StorageWorks Fibre Channel Storage Hubs (7- or 12-port)
- 2 Compaq StorageWorks RA4000 Controllers per RA4000
- 2 Compaq StorageWorks Fibre Channel Host Adapters per server
- Network interface cards (NICs)
- Gigabit Interface Converter-Shortwave (GBIC-SW) modules
- Cables
  - Multi-mode Fibre Channel cable
  - Ethernet crossover cable
  - Network (LAN) cable

The Compaq ProLiant Cluster HA/F200 includes these software solution components:

- Microsoft Windows NT Server 4.0 Enterprise Edition
- Compaq SmartStart and Support Software CD
- Compaq Support Software Diskette for Windows NT (NT SSD)
- Compaq Redundancy Manager (Fibre Channel)
- Compaq Cluster Verification Utility
- Compaq Insight Manager (optional)
- Compaq Insight Manager XE (optional)
- Compaq Intelligent Cluster Administrator (optional)

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NOTE: See Appendix C, "Software and Firmware Versions," for the necessary software version levels for your cluster.

The following illustration depicts the basic HA/F200 configuration.

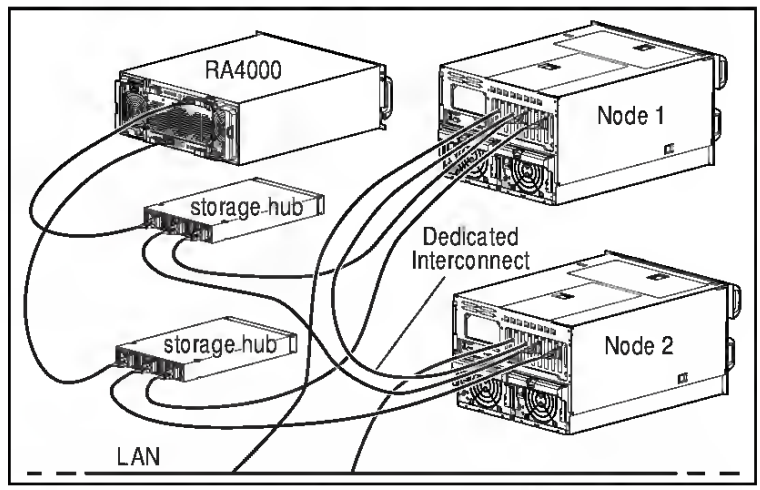

Figure 1-2. Hardware components of the Compaq ProLiant Cluster HA/F200

The Compaq ProLiant Cluster HA/F200 configuration is a cluster with one or more Compaq StorageWorks RAID Array 4000s, two Compaq StorageWorks Fibre Channel Storage Hubs (7- or 12-port), two Compaq ProLiant servers, two Compaq StorageWorks Fibre Channel Host Adapters per server, two Compaq StorageWorks RA4000 Controllers per RA4000, and a dedicated interconnect.

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Compaq ProLiant Servers

Compaq industry standard servers are a primary component of all models of Compaq ProLiant Clusters. At the high end of the ProLiant server line, several high availability and manageability features are incorporated as a standard part of the server feature set. These include online backup processors, a PCI bus with hot-plug capabilities, redundant hot-pluggable fans, redundant processor power modules, redundant Network Interface Controller (NIC) support, dual-ported hot-pluggable 10/100 NICs and redundant hot-pluggable power supplies (on most high-end models). Many of these features are available at the low end and mid range of the Compaq ProLiant server line, as well.

Compaq has logged thousands of hours testing multiple models of Compaq servers in clustered configurations and has successfully passed the Microsoft Cluster Certification Test Suite on numerous occasions. In fact, Compaq was the first vendor to be certified using a shared storage subsystem connected to ProLiant servers through Fibre Channel Arbitrated Loop technology.

NOTE: Visit the Compaq High Availability website (http://www.compaq.com/highavailability) to obtain a comprehensive list of cluster-certified servers.

Compaq StorageWorks RAID Array 4000 Storage System

Microsoft Cluster Server (MSCS) is based on a cluster architecture known as *shared storage clustering*, in which clustered servers share access to a common set of hard drives. MSCS requires all clustered (shared) data to be stored in an external storage system.

The Compaq StorageWorks RAID Array 4000 storage system is the shared storage system for the Compaq ProLiant Clusters HA/F100 and HA/F200. The storage system consists of the following components and options:

- Compaq StorageWorks RAID Array 4000
- Compaq StorageWorks Fibre Channel Storage Hub (7- or 12-port)
- Compaq StorageWorks RA4000 Controllers
- Compaq StorageWorks Fibre Channel Host Adapters

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- Gigabit Interface Converter-Shortwave (GBIC-SW) modules
- Cables
  - Multi-mode Fibre Channel cable
  - Ethernet crossover cable
  - Network (LAN) cable

Each of these components is discussed in the following sections. For detailed information, refer to the following guides:

- *Compaq StorageWorks RAID Array 4000 User Guide*
- Compaq StorageWorks RAID Array 4000 Configuration Poster
- Compaq StorageWorks RAID Array 4000 Redundant Array Controller Configuration Poster
- *Compaq StorageWorks Fibre Channel Host Adapter Installation Guide*
- *Compaq StorageWorks Fibre Channel Storage Hub 7 Installation Guide*
- *Compaq StorageWorks Fibre Channel Storage Hub 12 Installation Guide*
- *Compaq Fibre Channel Troubleshooting Guide*

For more information about shared storage clustering, refer to the *Microsoft Cluster Server Administrator's Guide*.

Compaq StorageWorks RAID Array 4000

The Compaq StorageWorks RAID Array 4000 (RA4000, previously Compaq Fibre Channel Storage System) is the storage cabinet that contains the disk drives, power supply, and array controller. The RA4000 can hold twelve 1-inch or eight 1.6-inch Wide-Ultra SCSI drives. The RA4000 supports the same hot-pluggable drives as Compaq Servers and Compaq ProLiant Storage Systems, online capacity expansion, online spares, and RAID fault tolerance of SMART-2 Array Controller technology. The RA4000 also supports hot-pluggable, redundant power supplies and fans, hot-pluggable hard drives, and MSCS.

The HA/F100 and HA/F200 ProLiant Clusters must have at least one RA4000 set up as external shared storage. Consult the *Order and Configuration Guide for Compaq ProLiant Cluster HA/F100 and HA/F200* at the Compaq High Availability website (http://www.compaq.com/highavailability) to determine the maximum supported cluster configuration.

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Compaq StorageWorks Fibre Channel Storage Hubs

The servers in a Compaq ProLiant Cluster HA/F100 and HA/F200 are connected to one or more Compaq StorageWorks Raid Array 4000 shared external storage systems using industry-standard Fibre Channel Arbitrated Loop (FC-AL) technology. The components used to implement the Fibre Channel Arbitrated Loop include shortwave (multi-mode) fiber optic cables, Gigabit Interface Converters-Shortwave (GBIC-SW) and Fibre Channel storage hubs. The Compaq StorageWorks Fibre Channel Storage Hub is a critical component of the FC-AL configuration and allows up to five RA4000s to be connected to the cluster servers in a "star" topology. For the HA/F100, a single hub is used. For the HA/F200, two redundant hubs are used. Either the 7-port or 12-port hub may be used in both types of clusters. For the HA/F200 cluster, 7-port and 12-port hubs may be combined, if desired. If the maximum number of supported RA4000s (currently five) are connected to either type of cluster using a 12-port hub, there will be unused ports. Compaq does not currently support using these ports to connect additional RA4000s. Other FC-AL capable devices such as tape backup systems should not be connected to these unused ports under any circumstances.

Compaq StorageWorks RA4000 Controller

The Compaq StorageWorks RA4000 Controller is fully RAID capable and manages all of the drives in the RA4000 storage array. Each RA4000 is shipped with one controller installed. In an HA/F100 cluster, each array controller is connected to both servers through a single Fibre Channel storage hub. In an HA/F200 cluster, the addition of a second Compaq StorageWorks RA4000 Redundant Controller is required to provide redundancy. These redundant controllers are connected to each server through two separate, and redundant, Fibre Channel storage hubs. This dual-connection configuration implements a vital aspect of the enhanced high availability features of the HA/F200 cluster.

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Compaq StorageWorks Fibre Channel Host Adapter

Compaq StorageWorks Fibre Channel Host Adapters (host bus adapters) are the interface between the server and the RA4000 storage system. At least two host bus adapters (PCI or EISA), one for each cluster node, are required in the Compaq ProLiant Cluster HA/F100. At least four host bus adapters (PCI only), two for each cluster node, are required in the HA/F200 configuration.

For more information about this product, refer to the *Compaq StorageWorks Fibre Channel Host Adapter Installation Guide*.

Gigabit Interface Converter-Shortwave

Two Gigabit Interface Converter-Shortwave (GBIC-SW) modules are required for each Fibre Channel cable installed. Two GBIC-SW modules are provided with each RA4000 and host bus adapter.

GBIC-SW modules hot-plug into Fibre Channel storage hubs, array controllers, and host bus adapters. These converters provide ease of expansion and 100 MB/s performance. GBIC-SW modules support distances up to 500 meters using multi-mode fibre optic cable.

Cables

Three general categories of cables are used for Compaq ProLiant HA/F100 and HA/F200 clusters:

Server to Storage

Shortwave (multi-mode) fiber optic cables are used to connect the servers, hubs and RA4000s in a Fibre Channel Arbitrated Loop configuration.

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Cluster Interconnect

Two types of cluster interconnect cables may be used depending on the type of devices used to implement the interconnect, and whether the interconnect is dedicated or shared:

1. Ethernet
   If Ethernet NICs are used to implement the interconnect, there are three options:

   Dedicated Interconnect Using an Ethernet Crossover Cable: An Ethernet crossover cable (supplied in both the HA/F100 and HA/F200 kits) can be used to connect the NICs directly together to create a dedicated interconnect.

   Dedicated Interconnect Using Standard Ethernet Cables and a private Ethernet Hub: Standard Ethernet cables can be used to connect the NICs together through a private Ethernet hub to create another type of dedicated interconnect. Note that an Ethernet crossover cable should *not* be used when using an Ethernet hub because the hub performs the crossover function.

   Shared Interconnect Using Standard Ethernet Cables and a Public Hub: Standard Ethernet cables may also be used to connect the NICs to a public network to create a nondedicated interconnect.

2. ServerNet
   If Compaq ServerNet adapters are used to implement the interconnect, special ServerNet cables must be used.

Network Interconnect

Standard Ethernet cables are used to provide this type of connection.

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Cluster Interconnect

The cluster interconnect is a data path over which nodes of a cluster communicate. This type of communication is termed *intracluster communication.* At a minimum, the interconnect consists of two network adapters (one in each server) and a cable connecting the adapters.

The cluster nodes use the interconnect data path to:

- Communicate individual resource and overall cluster status
- Send and receive heartbeat signals
- Update modified registry information

IMPORTANT: MSCS requires TCP/IP as the cluster communication protocol. When configuring the interconnects, be sure to enable TCP/IP.

Client Network

Every client/server application requires a local area network, or LAN, over which client machines and servers communicate. The components of the LAN are no different than with a stand-alone server configuration.

Because clients desiring the full advantage of the cluster will now connect to the cluster rather than to a specific server, configuring client connections will differ from those for a stand-alone server. Clients will connect to virtual servers, which are cluster groups that contain their own IP addresses.

Within this guide, communication between the network clients and the cluster is termed *cluster-to-LAN communication.*

Private or Public Interconnect

There are two types of interconnect paths:

- A private interconnect (also known as a dedicated interconnect) is used solely for intracluster (node-to-node) communication. Communication to and from network clients does not occur over this type of interconnect.
- A public interconnect not only takes care of communication between the cluster nodes, it also shares the data path with communication between the cluster and its network clients.

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For more information about Compaq-recommended interconnect strategies, refer to the White Paper, "Increasing Availability of Cluster Communications in a Windows NT Cluster," available from the Compaq High Availability website (http://www.compaq.com/highavailability).

Interconnect Adapters

Ethernet adapters, or Compaq ServerNet adapters, can be used for the interconnect between the servers in a Compaq ProLiant Cluster. Either 10Mb/sec, or 100Mb/sec, Ethernet may be used. ServerNet adapters have built-in redundancy and provide a high-speed interconnect with 100MB/sec aggregate throughput.

Ethernet adapters can be connected together using an Ethernet crossover cable or a private Ethernet hub. Both of these options provide a dedicated interconnect.

Implementing a direct Ethernet or ServerNet connection minimizes the potential single points of failure.

Redundant Interconnects

To reduce potential disruptions of intracluster communication, use a redundant path over which communication can continue if the primary path is disrupted.

Compaq recommends configuring the client LAN as a backup path for intracluster communication. This provides a secondary path for the cluster heartbeat in case the dedicated primary path for intracluster communications fails. This is configured when installing the cluster software, or it can be added later using the MSCS Cluster Administrator.

It is also important to provide a redundant path to the client LAN. This can be done by using a second NIC as a hot standby for the primary client LAN NIC.

There are two ways to achieve this, and the method you choose is dependent on your hardware. One way is through use of the Redundant NIC Utility available on all Compaq 10/100 Fast Ethernet products. The other option is through the use of the Network Fault Tolerance feature designed to operate with the Compaq 10/100 Intel silicon-based NICs. These features allow two NICs to be configured so that one is a hot backup for the other.

For detailed information about interconnect redundancy, refer to the Compaq White Paper, "Increasing Availability of Cluster Communications in a Windows NT Cluster," available from the Compaq High Availability website (http://www.compaq.com/highavailability).

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Microsoft Software

Microsoft Windows NT Server 4.0/Enterprise Edition (Windows NTS/E) is the operating system for the Compaq ProLiant Clusters HA/F100 and HA/F200. Microsoft Cluster Server (MSCS) is part of Windows NTS/E. As the core component of Windows NT clustering, MSCS provides the underlying technology to:

- Send and receive heartbeat signals between the cluster nodes.
- Monitor the state of each cluster node.
- Initiate failover and failback events.

NOTE: MSCS will only run with Windows NTS/E. Previous versions of Windows NT are not supported.

Microsoft Cluster Administrator, another component of Windows NTS/E, allows you to do the following:

- Define and modify cluster groups
- Manually control the cluster
- View the current state of the cluster

NOTE: Microsoft Windows NTS/E must be purchased separately from your Compaq ProLiant Cluster, through your Microsoft reseller.

Compaq Software

Compaq offers an extensive set of features and optional tools to support the configuration and management of your Compaq ProLiant Cluster:

- Compaq SmartStart and Support Software CD
- Compaq Redundancy Manager (Fibre Channel)
- Compaq Insight Manager
- Compaq Insight Manager XE
- Compaq Intelligent Cluster Administrator
- Compaq Cluster Verification Utility

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Compaq SmartStart and Support Software CD

Compaq SmartStart is located on the SmartStart and Support Software CD shipped with ProLiant servers. SmartStart is the recommended way to configure the Compaq ProLiant Cluster HA/F100 or HA/F200. SmartStart uses a step-by-step process to configure the cluster and load the system software. For information concerning SmartStart, refer to the Compaq Server Setup and Management pack.

For information about using SmartStart to install the Compaq ProLiant Cluster HA/F100 and HA/F200, see chapters 3 and 4 of this guide.

Compaq Array Configuration Utility

The Compaq Array Configuration Utility, found on the Compaq SmartStart and Support Software CD, is used to configure the array controller, add disk drives to an existing configuration, and expand capacity.

Compaq System Configuration Utility

The SmartStart and Support Software CD also contains the Compaq System Configuration Utility. This utility is the primary means to configure hardware devices in your server, such as I/O addresses, boot order of disk controllers, and so on.

For information concerning the Compaq System Configuration Utility, refer to the Compaq Server Setup and Management pack.

Compaq Support Software Diskette (NT SSD)

The Compaq Support Software Diskette for Windows NT (NT SSD) contains device drivers and utilities that enable you to take advantage of specific capabilities offered on Compaq products. These drivers are provided for use with Compaq hardware only.

The NT SSD is included in the Compaq Server Setup and Management pack.

Options ROMPaq Utility

The SmartStart and Support Software CD also contains the Options ROMPaq utility. Options ROMPaq updates the firmware on the Compaq StorageWorks RA4000 Controllers and the hard drives.

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Fibre Channel Fault Isolation Utility (FFIU)

The SmartStart and Support Software CD also contains the Fibre Channel Fault Isolation Utility (FFIU). The FFIU verifies the integrity of a new or existing FC-AL installation. This utility provides fault detection and help in locating a failing device on the FC-AL.

Compaq Redundancy Manager (Fibre Channel)

Compaq Redundancy Manager, a Compaq-written software component that works in conjunction with the Windows NT file system (NTFS), increases the availability of both single-server and clustered systems that use the Compaq StorageWorks RAID Array 4000 Storage System and Compaq ProLiant servers. Redundancy Manager can detect failures in the host bus adapter, array controller or other Fibre Channel Arbitrated Loop components. When such a failure occurs, I/O processing is rerouted through a redundant path, allowing applications to continue processing. This rerouting is transparent to the Windows NT file system. Therefore, in an HA/F200 configuration, it is not necessary for MSCS to fail resources over to the other node. Redundancy Manager, in combination with redundant hardware components, is the basis for the enhanced high availability features of the HA/F200.

Compaq Redundancy Manager (Fibre Channel) CD is included in the Compaq ProLiant Cluster HA/F200 kit.

Compaq Cluster Verification Utility

The Compaq Cluster Verification Utility (CCVU) is a software utility that can be used to validate several key aspects of the Compaq ProLiant Cluster HA/F100 and HA/F200 and their components.

The stand-alone utility can be run from either of the cluster nodes or remotely from a network client attached to the cluster. When CCVU is run remotely, it can validate any number of Windows NT clusters to which the client is attached.

The CCVU tests your cluster configuration in the following categories:

- A node test verifies that the clustered servers are supported in HA/F100 and HA/F200 cluster configurations.
- Networking tests verify that your setup meets the minimum cluster requirements for network cards, connectivity, and TCP/IP configuration.

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- Storage tests verify the presence and minimum configuration requirements of supported host bus adapters, array controllers, and external storage subsystem.
- System software tests verify that Microsoft Windows NT Server 4.0/ Enterprise Edition has been installed.

The Compaq Cluster Verification Utility CD is included in the HA/F100 and HA/F200 cluster kits. For detailed information about the CCVU, refer to the online documentation (CCVU.HLP) included on the CD.

Compaq Insight Manager

Compaq Insight Manager, loaded from the Compaq Management CD, is an easy-to-use, console-based software utility for collecting server and cluster information. Compaq Insight Manager performs the following functions:

- Monitors fault conditions and system status
- Monitors shared storage and interconnect adapters
- Forwards server alert fault conditions
- Remotely controls servers

The Integrated Management Log collects and feeds data to Compaq Insight Manager. This log is used with the Insight Management Desktop (IMD), Remote Insight (optional controller), and SmartStart.

In Compaq servers, each hardware subsystem, such as disk storage, system memory, and system processor, has a robust set of management capabilities. Compaq Full Spectrum Fault Management notifies of impending fault conditions and keeps the server up and running in the unlikely event of a hardware failure.

For information concerning Compaq Insight Manager, refer to the Compaq Server Setup and Management pack.

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Compaq Insight Manager XE

Compaq Insight Manager XE is a Web-based management system. It can be used in conjunction with Compaq Insight Manager agents as well as its own Web-enabled agents. This browser-based utility provides increased flexibility and efficiency for the administrator. It extends the functionality of Compaq Insight Manager and works in conjunction with the Cluster Monitor subsystem, providing a common data repository and control point for enterprise servers and clusters, desktops, and other devices using either SNMP- or DMI-based messaging.

Compaq Insight Manager XE is an optional CD available upon request from the Compaq System Management website (http://www.compaq.com/sysmanage).

Cluster Monitor

Cluster Monitor is a Web-based monitoring subsystem of Compaq Insight Manager XE. With Cluster Monitor, you can view all clusters from a single browser and configure monitor points and specific operational performance thresholds that will alert you when these thresholds have been met or exceeded on your application systems. Cluster Monitor relies heavily on the Compaq Insight Manager agents for basic information about system health. It also has custom agents that are designed specifically for monitoring cluster health. Cluster Monitor provides access to the Compaq Insight Manager alarm, device, and configuration information.

Cluster Monitor allows the administrator to view some or all of the clusters, depending on administrative controls that are specified when clusters are discovered by Compaq Insight Manager XE.

Compaq Intelligent Cluster Administrator

Compaq Intelligent Cluster Administrator extends Compaq Insight Manager and Cluster Monitor by enabling Administrator to configure and manage ProLiant clusters from a Web browser. With Compaq Intelligent Cluster Administrator, you can copy, modify, and dynamically install a cluster configuration on the same physical cluster or on any physical cluster anywhere in the system, through the Web.

Compaq Intelligent Cluster Administrator checks for any cluster destabilizing conditions, such as disk thresholds or application slowdowns, and reallocates cluster resources to meet processing demands. This software also performs dynamic allocation of cluster resources that may be failing without causing the cluster to fail over.

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Compaq Intelligent Cluster Administrator also provides initialized cluster configurations that allow rapid cluster generation as well as cluster configuration builder wizards for extending the Compaq initialized configurations.

Compaq Intelligent Cluster Administrator is included with the HA/F200 cluster kit and can be purchased as a stand-alone component for the HA/F100 cluster.

Resources for Application Installation

The client/server software applications are among the key components of any cluster. Compaq is working with its key software partners to ensure that cluster-aware applications are available and that the applications work seamlessly on Compaq ProLiant clusters.

Compaq provides a number of Integration TechNotes and White Papers to assist you with installing these applications in a Compaq ProLiant Cluster environment.

Visit the Compaq High Availability website (http://www.compaq.com/highavailability) to download current versions of these TechNotes and other technical documents.

IMPORTANT: Your software applications may need to be updated to take full advantage of clustering. Contact your software vendors to check whether their software supports MSCS and to ask whether any patches or updates are available for MSCS operation.

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Chapter 2

Designing the Compaq ProLiant Clusters HA/F100 and HA/F200

Before connecting any cables or powering on any machines, it is important to understand how all of the various cluster components and concepts fit together to meet your information system needs. The major topics discussed in this chapter are:

- Planning Considerations
- Capacity Planning
- Network Considerations
- Failover/Failback Planning

In addition to reading this chapter, read the planning chapter in *Microsoft Cluster Server Administrator's Guide*.

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Planning Considerations

To correctly assess capacity, network, and failover needs in your business environment, it is important to have a good understanding of clustering and the things that affect the availability of clusters. The items detailed in this section will help you design your Compaq ProLiant Cluster so that it addresses your specific availability needs.

- Cluster configuration design is addressed in "Cluster Configurations."
- A step-by-step approach to creating cluster groups is discussed in "Cluster Groups."
- Recommendations regarding how to reduce or eliminate single points of failure are contained in the "Reducing Single Points of Failure in the HA/F100 Configuration" section of this chapter. By definition, a *highly* available system is not *continuously* available and therefore may have single points of failure.

NOTE: The discussion in this chapter relating to single points of failure applies only to the Compaq ProLiant Cluster HA/F100. The HA/F200 includes dual redundant loops, which eliminate certain single points of failure contained in the HA/F100.

Cluster Configurations

Although there are many ways to set up clusters, most configurations fall into two categories: active/active and active/standby.

Active/Active Configuration

The core definition of an active/active configuration is that each node is actively processing data when the cluster is in a normal operating state. Both the first and second nodes are "active." Because both nodes are processing client requests, an active/active design maximizes the use of all hardware in both nodes.

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An active/active configuration has two primary designs:

- The first design uses Microsoft Cluster Server (MSCS) failover capabilities on both nodes, enabling Node1 to fail over clustered applications to Node2 and enabling Node2 to fail over clustered applications to Node1. This design optimizes availability since both nodes can fail over applications to each other.
- The second design is a one-way failover. For example, MSCS may be set up to allow Node1 to fail over clustered applications to Node2, but not to allow Node2 to fail over clustered applications to Node1. While this design increases availability, it does not maximize availability since failover is configured on only one node.

When designing cluster nodes to fail over to each other, ensure that each server has enough capacity, memory, and processor power to run all applications (all applications running on the first node plus all clustered applications running on the other node).

When designing your cluster so that only one node (Node1) fails over to the other (Node2), ensure that Node2 has enough capacity, memory, and CPU power to execute not only its own applications, but to run the clustered applications that can fail over from Node1.

Another consideration when determining your servers' hardware is understanding your clustered applications' required level of performance when the cluster is in a *degraded state* (when one or more clustered applications is running on a secondary node). If Node2 is running near peak performance when the cluster is in a normal operating state, and if several clustered applications are failed over from Node1, Node2 will likely execute the clustered applications more slowly than when they were executed on Node1. Some level of performance degradation may be acceptable. Determining how much degradation is acceptable depends on the company.

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Example 1: File & Print/File & Print

An example business scenario involves two file and print servers. The Human Resources (HR) department uses one server, and the Marketing department uses the other. Both servers actively run their own file shares and print spoolers while the cluster is in its normal state (an active/active design).

If the HR server encounters a failure, it fails over its file and print services to the Marketing server. HR clients experience a slight disruption of service while the file shares and print spooler fail over to their secondary server. Any jobs that were in the print spooler before the failure event will now print from the Marketing server.

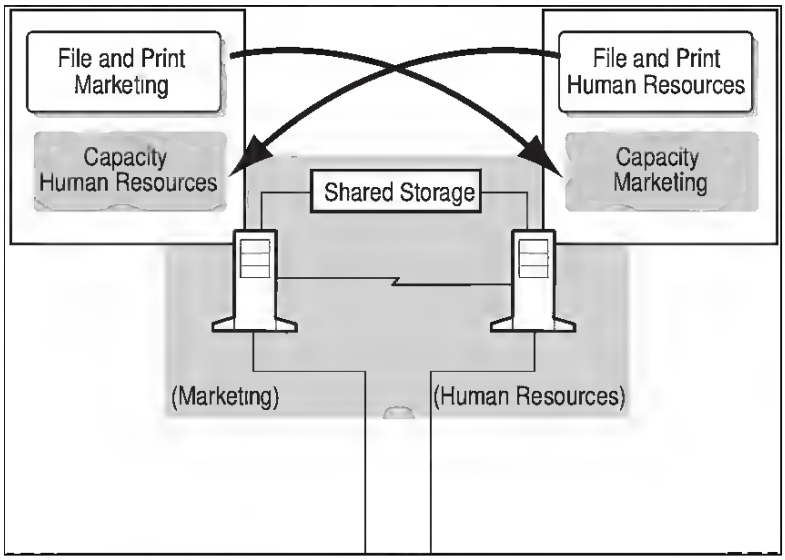

Figure 2-1. Active/active example 1

When failover is complete, all of the HR clients have full access to their file shares and print spooler. Marketing clients do not experience any disruption of service. All clients may experience slowed performance while the cluster runs in a degraded state.

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Example 2: Database/Database

Another scenario has two distinct database applications running on two separate cluster nodes. One database application maintains Human Resources records, and its primary node is set to the HR database node. The other database application is used for market research, and its primary node is set to the Marketing database node.

While in a normal state, both cluster nodes run at expected performance levels. If the Marketing server encounters a failure, the market research application and associated data resources fail over to their secondary node, the HR database server. The Marketing clients experience a slight disruption of service while the database resources are failed over, the database transaction log is rolled back, and the information in the database is validated. When the database validation is complete, the market research application is brought online on the HR database node and the Marketing clients can reconnect to it. While the Marketing database validation is occurring, the HR clients do not experience any disruption of service.

Example 3: File & Print/Database

In this example, a business uses a single server to run its order entry department. The same department has a file and print server. While order entry is business-critical and requires maximum availability, the file and print server can be unavailable for several hours without impacting revenue. In this scenario, the order entry database is configured to use the file and print server as its secondary node. However, the file and print server will not be configured to fail over applications to the order entry server.

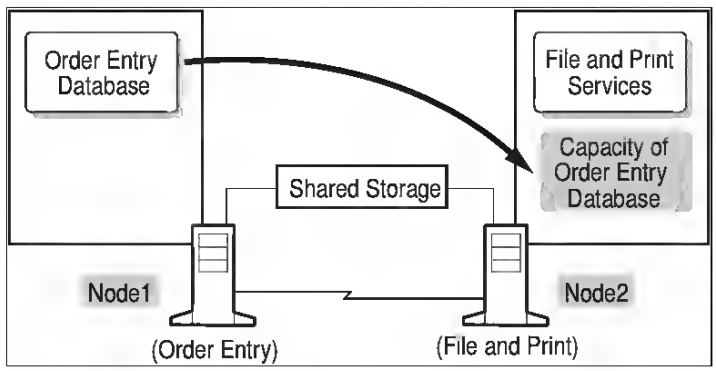

Figure 2-2. Active/active example 3

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If the node running the order entry database encounters a failure, the database fails over to its secondary node. The order entry clients experience a slight disruption of service while the database resources are failed over, the database transaction log is rolled back, and the information in the database is validated. When the database validation is complete, the order entry application is brought online on the file and print server and the clients can reconnect to it. While the database validation is occurring, file and print activities continue without disruption.

If the file and print server encounters a failure, those services are not failed over to the order entry server. File and print services are offline until the problem is resolved and the node is brought back online.

Active/Standby Configuration

The primary difference between an active/active configuration and an active/standby configuration is the number of servers actively processing data. In active/standby, only one server is processing data (active) while the other (the standby server) is in an idle state.

The standby server must be logged in to the Windows NT domain and MSCS must be up and running. However, no applications are running. The standby server's only purpose is to take over failed clustered applications from its partner. The standby server is not a preferred node for any clustered applications and, therefore, does not fail-over any applications to its partner server.

Because the standby server does not process data until it accepts failed over applications, the limited use of the server may not justify the cost of the server. However, the cost of standby servers is justified when performance and availability are paramount to a business' operations.

The standby server should be designed to run all of the clustered applications with little or no performance degradation. Since the standby server is not running any applications while the cluster is in a normal operating state, a failed-over clustered application will likely execute with the same speed and response time as if it were executing on the primary server.

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Example – Database/Standby Server

An example business scenario describes a mail order business whose competitive edge is quick product delivery. If the product is not delivered on time, the order is void and the sale is terminated. The business uses a single server to perform queries and calculations on order entry information, translating sales orders into packaging and distribution instructions for the warehouse. With an estimated downtime cost of $1,000/hour, the company determines that the cost of a standby server is justified.

This mission-critical (active) server is clustered with a standby server. If the active server encounters a failure, this critical application and all its resources fail over to the standby server, which validates the database and brings it online. The standby server now becomes active and the application executes at an acceptable level of performance.

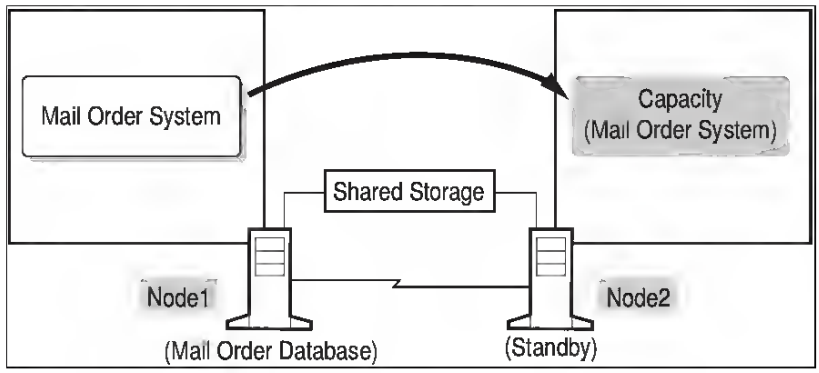

Figure 2-3 Active/standby example

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Cluster Groups

Understanding the relationship between your company's business functions and cluster groups is essential to getting the most from your cluster. Business functions rely on computer systems to support activities such as transaction processing, information distribution, and information retrieval. Each computer activity relies on applications or services, and each application depends on software and hardware subsystems. For example, most applications need a storage subsystem to hold their data files.

This section is designed to help you understand which subsystems, or resources, must be available for either cluster node to run a clustered application properly.

Creating a Cluster Group

The easiest approach to creating a cluster group is to start by designing a resource dependency tree. A resource dependency tree has as its top level the business function for which cluster groups are created. Each cluster group has branches that indicate the resources upon which the group is dependent.

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Resource Dependency Tree

The following steps describe the process of creating a resource dependency tree. Each step is illustrated by adding information to a sample resource dependency tree. The sample is for a hypothetical Web Sales Order business function, which consists of two cluster groups: a database server (a Windows NT application) and a Web server (a Windows NT service).

NOTE: For this example, it is assumed that each cluster group can communicate with the other even if they are not executing on the same node, for example, by means of an IP address. With this assumption, one cluster group can fail over to the other node, while the remaining cluster group continues to execute on its primary node.

1. List each business function that requires a clustered application or service.

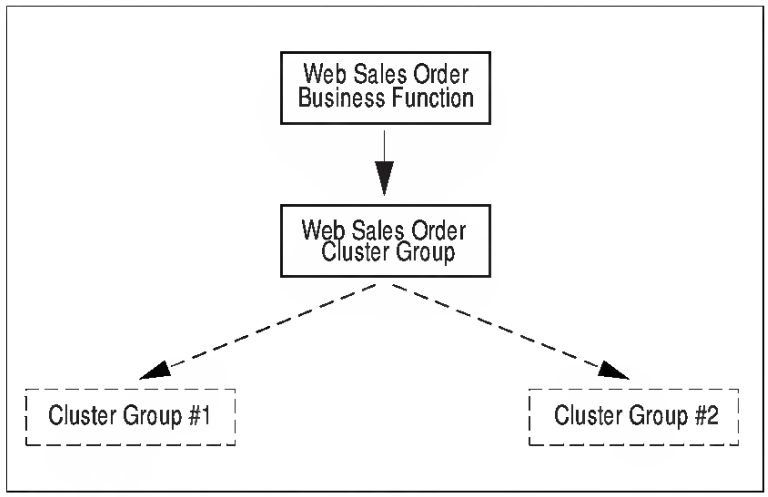

Figure 2-4. Resource dependency tree: step 1

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2. List each application or service required for each business function.

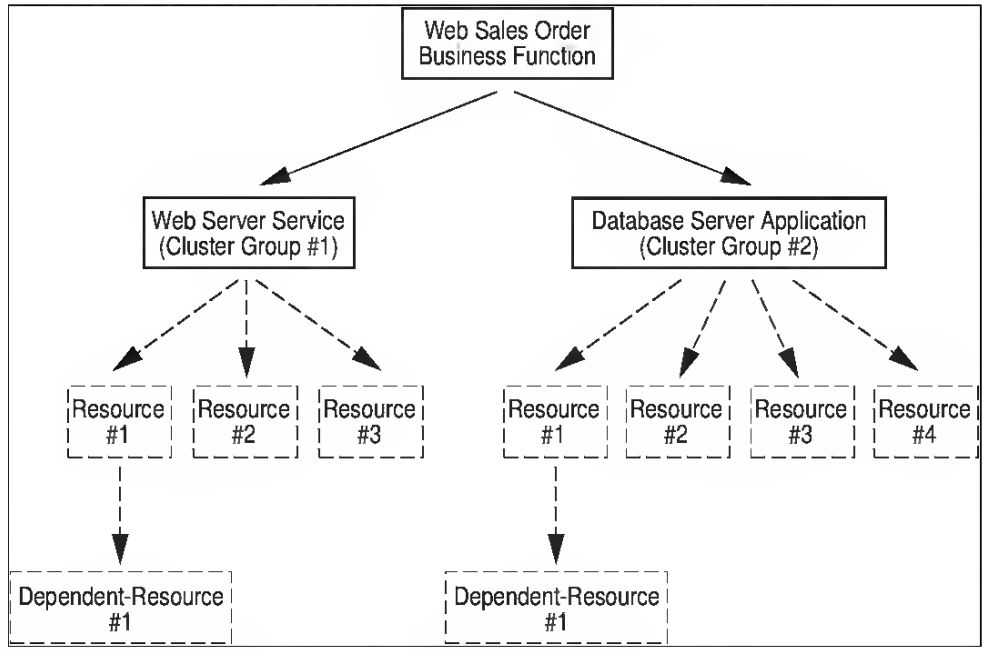

Figure 2-5. Resource dependency tree: step 2

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3. List the immediate dependencies for each application (or service).

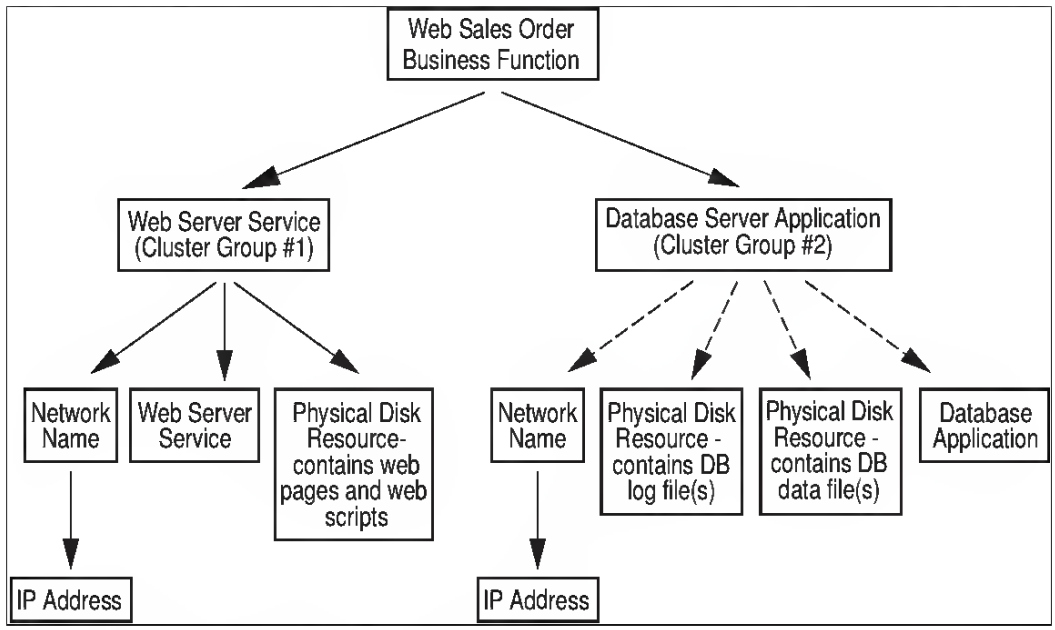
Web Sales Order Business Function
Web Server Service (Cluster Group #1)
Database Server Application (Cluster Group #2)
Network Name
Web Server Service
Physical Disk Resource- contains web pages and web scripts
Network Name
Physical Disk Resource - contains DB log file(s)
Physical Disk Resource - contains DB data file(s)
Database Application
IP Address
IP Address

Figure 2-6. Resource dependency tree: step 3

4. Transfer the resource dependency tree into a Cluster Group Definition worksheet.

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Figure 2-7 illustrates the worksheet for the Web Sales Order business function. A blank copy of the worksheet is provided in Appendix A.

Cluster Group Definition Worksheet				
Cluster Function	Web Sales Order			
Group #1	Web Server Service			
Group #2	Database Server Application			
Resource Definitions				
Group #1 (Web Server Service)				
Resource #1	Network Name			
	Sub Resource 1	Sub Resource 2	Sub Resource 3	Sub Resource 4
	IP Address			
Resource #2	Physical Disk Resource-contains Web pages and Web scripts			
	Sub Resource 1	Sub Resource 2	Sub Resource 3	Sub Resource 4
Resource #3	Web Server Service			
	Sub Resource 1	Sub Resource 2	Sub Resource 3	Sub Resource 4
Resource #4	N/A			
	Sub Resource 1	Sub Resource 2	Sub Resource 3	Sub Resource 4
Group #2 (Database Server Application)				
Resource #1	Network Name			
	Sub Resource 1	Sub Resource 2	Sub Resource 3	Sub Resource 4
	IP Address			
Resource #2	Physical Disk Resource-contains database log files			
	Sub Resource 1	Sub Resource 2	Sub Resource 3	Sub Resource 4
Resource #3	Physical Disk Resource-contains database data files			
	Sub Resource 1	Sub Resource 2	Sub Resource 3	Sub Resource 4
Resource #4	Database Application			
	Sub Resource 1	Sub Resource 2	Sub Resource 3	Sub Resource 4

Figure 2-7. Cluster Group Definition Worksheet (example)

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Use the resource dependency tree concept to review your company's availability needs. It is a useful exercise, directing you to record the exact design and definition of each cluster group.

Reducing Single Points of Failure in the HA/F100 Configuration

The final planning consideration is reducing single points of failure. Depending on your needs, you may leave all vulnerable areas alone, accepting the risk associated with a potential failure. Or, if the risk of failure is unacceptable for a given area, you may elect to use a redundant component to minimize, or remove, the single point of failure.

NOTE: Although not specifically covered in this section, redundant server components (such as power supplies and processor modules) should be used wherever possible. These features will vary based upon your specific server model.

The single points of failure described in this section are:

- Cluster interconnect
- Fibre Channel data paths
- Non-shared disk drives
- Shared disk drives

NOTE: The Compaq ProLiant Cluster HA/F200 addresses the single points of failure listed above with its dual redundant loop configuration. For more information, refer to the "Enhanced High Availability Features of the HA/F200" section of this chapter.

Cluster Interconnect

The interconnect is the primary means for the cluster nodes to communicate. Intracluster communication is crucial to the health of the cluster. If communication between the cluster nodes ceases, MSCS must determine the state of the cluster and take action, in most cases bringing the cluster groups offline on one of the nodes and failing over all cluster groups to the other node.

Following are two strategies for increasing the availability of intracluster communication. Combined, these strategies provide even more redundancy.

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MSCS Configuration

MSCS allows you to configure a primary and backup path for intracluster communication, which will reduce the possibility of an intracluster communication disruption. Any network interface card (NIC) in the nodes can be configured to serve as a backup path for node-to-node communication. When the primary path is disrupted, the transfer of communication responsibilities goes undetected by applications running on the cluster. Whether a dedicated or public interconnect has been set up, a separate NIC should be configured to act as a redundant interconnect. This is an easy and inexpensive way to add redundancy to intracluster communication.

Redundant Interconnect Card

Another strategy to increase availability is to use a redundant interconnect card. This may be done for either the dedicated intracluster communication path, or for the client LAN. If you are using a dedicated, direct-connection interconnect configuration, you can install a second dedicated, direct-connection interconnect.

NOTE: If you are using the ServerNet option as the interconnect, the card itself has a built-in level of redundancy. Each ServerNet PCI adapter has two data ports, thereby allowing two separate cables to be run to and from each cluster node. If the ServerNet adapter determines that data is being sent from one adapter but not received by the other, it will automatically route the information through its other port.

There are two implementations that provide identical redundant NIC capability. The implementation you choose will depend on your hardware. The Compaq Redundant NIC Utility (originally called Advanced Network Fault Detection and Correction Feature) is supported on all Compaq TI-based Ethernet and Fast Ethernet NICs, such as NetFlex-3 and Netelligent 10/100 TX PCI Ethernet NICs. The Network Fault Tolerance feature is designed to operate with the Compaq Intel-based 10/100 NICs. Combining these utilities with the appropriate NICs will enable a seamless, undetectable failover of the primary interconnect to the redundant interconnect.

NOTE: These two methods of NIC redundancy cannot be combined in a single redundant NIC pair: TI-based NICs may not be paired with Intel-based NICs to create a redundant pair. For more information, refer to the Compaq White Paper, "*High Availability Options Supported by Compaq Network Interface Controllers*," available at the Compaq High Availability website (http://www.compaq.com/highavailability).

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Because the purpose of the redundant interconnect is to increase the availability of the cluster, it is important to monitor the status of your redundant NICs. Compaq Insight Manager and Compaq Insight Manager XE simplify management of the interconnect by monitoring the state of the interconnect card. You can view status information and alert conditions for all cards in each node. If a failover event occurs due to a disruption in the heartbeat, you can use the Compaq Insight Manager tools to determine where the disruption originated.

Cluster-to-LAN Communication

Each cluster node must have at least one NIC that connects to the LAN. Through this connection, network clients can access applications and data on the cluster. If the LAN NIC fails in one of the nodes, any clients connected directly to the cluster node by means of the computer name, cluster node IP address, or MAC address of the NIC no longer have access to their applications. Clients connected to a virtual server on the cluster (via the IP address or network name of a cluster group) reconnect to the cluster through the surviving cluster node.

Failure of a LAN NIC in a cluster node may have serious repercussions. If your cluster is configured with a dedicated interconnect and a single LAN NIC, the failure of a LAN NIC will prevent network clients from accessing cluster groups running on that node. If the interconnect path is not disrupted, it is possible that a failover will not occur. The applications will continue to run on the node with the failed NIC; however, clients will be unable to access them.

Install redundant NICs and use the Compaq Redundant NIC Utility to reduce the possibility of LAN NIC failure. When your cluster nodes are configured with the utility, the redundant NIC automatically takes over operation if the primary NIC fails. Clients maintain their connection with their primary node and, without disruption, continue to have access to their applications.

Compaq offers a dual-port NIC that can utilize the Compaq Redundant NIC Utility. This also reduces the possibility of the failure scenario described above. However, if the entire NIC or the node slot into which the NIC is placed fails, the same failure scenario will occur.

Compaq Insight Manager and Compaq Insight Manager XE monitor the health of any network cards used for the LAN. If any of the cards experience a fault, the Compaq Insight Manager tools mark the card as "Offline" and change its condition to the appropriate status.

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Recommended Cluster Communication Strategy

The past two sections discussed the redundancy of intracluster and cluster-to-LAN communication. However, to obtain the most benefit while minimizing cost and complexity, view cluster communications as a single entity.

To create redundancy for both intracluster and cluster-to-LAN communication, first, employ physical hardware redundancy for the LAN NICs. Second, configure MSCS to use both the primary and redundant LAN NIC as backup for intracluster communication.

With this strategy, your cluster can continue normal operations (without a failover event) when each of the following points of failure are encountered:

- Failure of the interconnect card
- Failure of the port on the interconnect card
- Failure of the interconnect cable
- Failure of the port on the LAN NIC
- Failure of the LAN NIC (if redundant NICs, as opposed to dual-ported NICs, are used)
- Failure of the Ethernet cable running from a cluster node to the Ethernet hub (which connects to the LAN)

The following examples describe how to physically set up your cluster nodes to employ the Compaq-recommended strategy. For more information about the strategy, refer to the Compaq White Paper, "Increasing Availability of Cluster Communications in a Windows NT Cluster."

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Example 1

A Compaq dual-port NIC and a single-port NIC are used in this example. The first port of the dual-port NIC is a dedicated interconnect, and the second port is the backup path for the cluster-to-LAN network. The single-port NIC is configured as the primary network path for cluster-to-LAN communication.

The Compaq Advanced Network Control Utility is used to configure the second port on the dual-port NIC as the backup port of a redundant pair. The single port on the other NIC is configured to be the primary port for cluster-to-LAN communication.

The interconnect retains its fully redundant status when MSCS is configured to use the other network ports as interconnect backup. Failure of the primary interconnect path results in intracluster communications occurring over the single-port NIC, since it was configured in MSCS as the backup for intracluster communication. If the entire dual-port NIC fails, the cluster nodes still have a working communication path over the single-port NIC.

With this configuration, even a failure of the dual-port NIC results in the transfer of the cluster-to-LAN communication to the single-port NIC. Other than a failure of the network hub, the failure of any cluster network component will be resolved by the redundancy of this configuration.

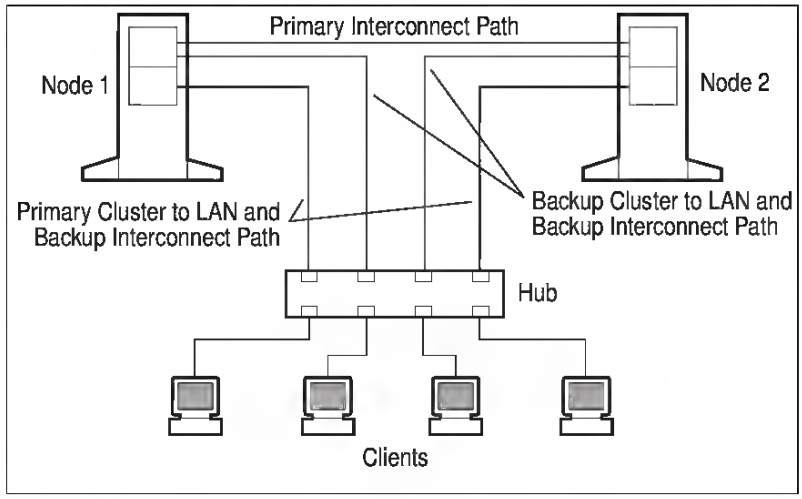

Figure 2-8. Use of dual-port NICs to increase redundancy

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Example 2

The second example configuration consists of three single-port NICs. One NIC is dedicated to intracluster communication. The other two NICs are used for cluster-to-LAN communication. The Compaq Advanced Network Control Utility is used to configure two of the NICs—one as the primary and one as the standby of a redundant pair.

The interconnect is fully redundant when MSCS is configured to use the other network cards as backups for the interconnect. Failure of the primary interconnect path results in intracluster communications occurring over the primary NIC of the redundant pair. If the entire interconnect card fails, the cluster nodes will still have a working communication path.

The cluster-to-LAN communication is fully redundant up to the network hub. With this configuration, even a failure of the primary NIC results only in the transfer of the network path to the standby NIC. Other than a failure of the network hub, any failure of any cluster network component will be resolved by the redundancy of this configuration.

The primary disadvantage of this configuration as compared to Example 1 is that an additional card slot is used by the third NIC.

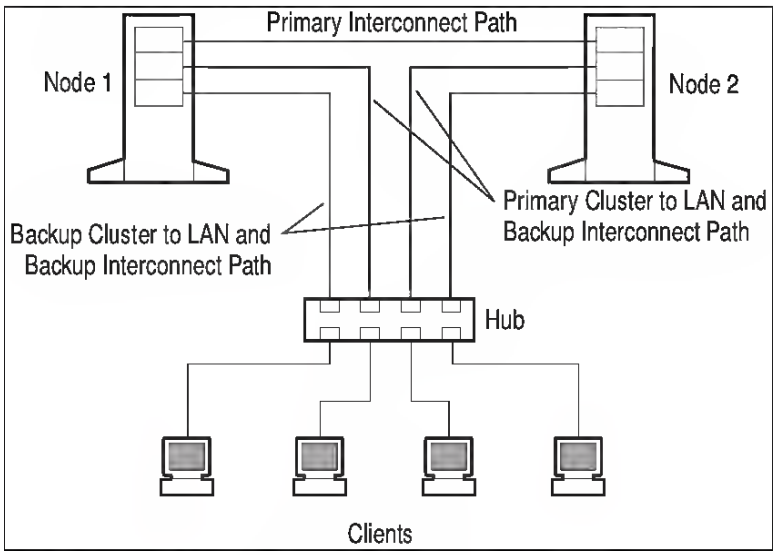

Figure 2-9. Use of three NICs to increase redundancy

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HA/F100 Fibre Channel Data Paths

The Compaq StorageWorks RAID Array 4000 storage system (formerly Compaq Fibre Channel storage system) is the mechanism with which ProLiant Clusters implement shared storage. Generally, the storage system consists of Compaq StorageWorks Host Adapters (host bus adapters) in each server, a Compaq StorageWorks Fibre Channel Storage Hub, a Compaq StorageWorks RA4000 Controller (array controller), and a Compaq StorageWorks RAID Array 4000 into which the SCSI disks are placed.

The RA4000 storage system has two distinct data paths, separated by the storage hub:

- The first data path runs from the host bus adapters in the servers to the storage hub.
- The second data path runs from the storage hub to the RA4000.

The effects of a failure will vary depending on whether the failure occurred on the first or second data path.

Failure of the Host Bus Adapter-to-Storage Hub Data Path

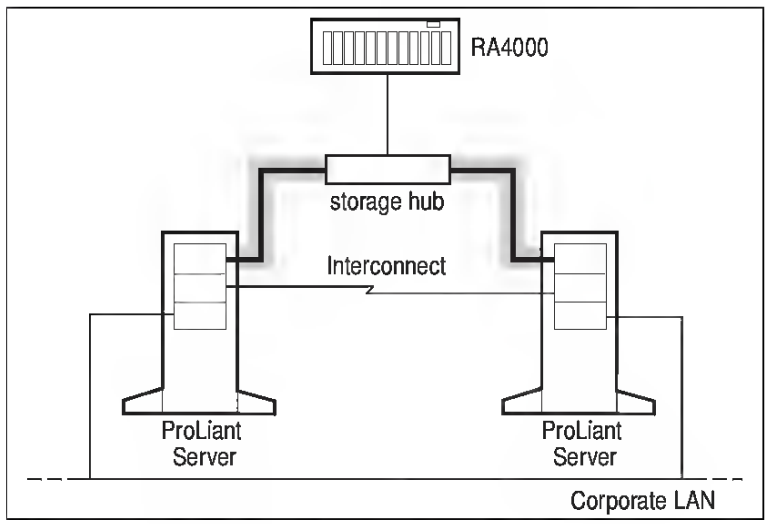

Figure 2-10. Host bus adapter-to-storage hub data path

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If the host bus adapter-to-storage hub path fails, it results in a failover of all applications. For instance, if one server can no longer access the storage hub (and by extension the shared storage), all of the cluster groups that depend on shared storage will fail over to the second server. The cost of failure is relatively minor. It is the downtime experienced by users while the failover event occurs.

Note that the Compaq Insight Manager tools monitor the health of the RA4000 storage system. If any part of the Fibre Channel data path disrupts a server's access to the RA4000, the array controller status changes to "Failed" and the condition is red. The red condition bubbles up to higher-level Compaq Insight Manager screens and eventually to the device list.

NOTE: The Compaq Insight Manager tools display a failure of physical hardware through the Mass Storage button on the View screen, marking the hardware "Failed." A logical drive in the cluster is reported on the Cluster Shared Resources screen as a logical disk resource. Compaq Insight Manager and Compaq Insight Manager XE do not associate the logical drive with the physical hardware.

Failure of the Hub-to-RA4000 Data Path

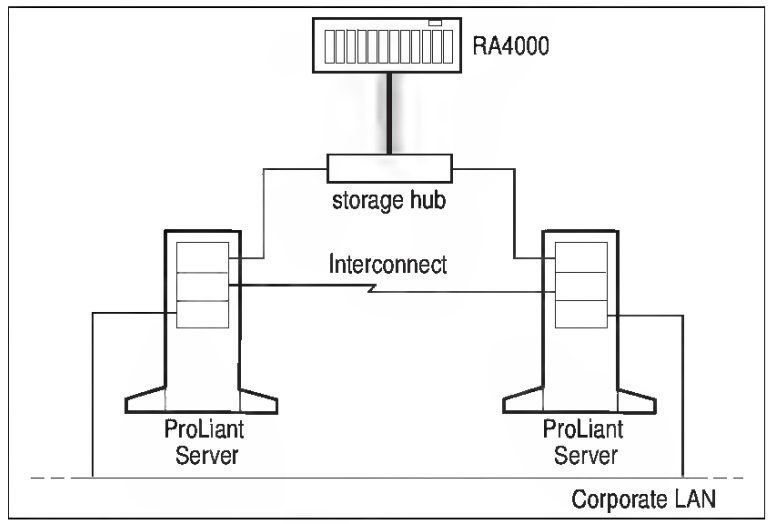

Figure 2-11. Hub-to-RA4000 data path

The second data path, from the storage hub to the RA4000, has more severe implications when it fails. If this data path fails, all clustered applications become inoperable. Even attempting to fail the applications to another cluster node will not gain access to the RA4000.

NOTE: This failure scenario can be avoided by deploying the redundant Fibre Channel loop configuration of the Compaq ProLiant Cluster HA/F200.

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Without access to shared storage, clustered applications cannot reach their data or log files. The data, however, is unharmed and remains safely stored on the physical disks inside the RA4000. If a database application was running when this failure occurred, some in-progress transactions will be lost. The database will need to be rolled back and the in-progress transactions re-entered.

Like the server-to-storage hub data path, the Compaq Insight Manager tools detect this fault, change the RA4000 status to "Failed," and change its condition to red. The red condition bubbles up through Compaq Insight Manager screens, eventually to the device list.

Nonshared Disk Drives

Nonshared disk drives, or local storage, operate the same way in a cluster as they do in a single-server environment. These drives can be in the server drive bays or in an external storage cabinet. As long as they are not accessible by both servers, they are considered nonshared.

Treat nonshared drives in a clustered environment as you would in a nonclustered environment. Most likely, some form of RAID is used to protect the drives and restore a failed drive. Since the operating system is stored on these drives, use either hardware or software RAID to protect the information. Hardware RAID is available with Compaq's SMART-2 Controller or by using a nonshared storage system.

Shared Disk Drives

Shared disk drives are contained in the RA4000, which is accessible by each cluster node. Employ hardware RAID 1 or 5 on all of your shared disk drives. This is configured using the Compaq Array Configuration Utility.

If RAID 1 or 5 is not used, failure of a shared disk drive will disrupt service to all clustered applications and services that depend on the drive. Failover of a cluster node will not resolve this failure, since neither server can read from a failed drive.

> **NOTE:** Windows NT software RAID is not available for shared drives when using MSCS. Hardware RAID is the only available RAID option for shared storage.

As with other system failures, Compaq Insight Manager monitors the health of disk drives and will mark a failed drive as "Failed."

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Enhanced High Availability Features of the HA/F200

A "single point of failure" refers to any component in the system that, should it fail, prevents the system from functioning. Single points of failure in hardware can be minimized, and in some cases eliminated, by using redundant components. The most effective way of accomplishing this is by clustering.

The Compaq ProLiant Cluster HA/F100 reduces the single points of failure that exist in a single-server environment by allowing two servers to share storage and take over for each other in the event that one server fails. The Compaq ProLiant Cluster HA/F200 goes one step further by implementing a dual redundant Fibre Channel Arbitrated Loop configuration.

The Compaq ProLiant Cluster HA/F200 further enhances high availability through the use of additional, redundant, components in the server-to-storage connection and in the shared storage system itself. In the event of a failure, processing is switched to an alternate path without affecting applications and end users. In fact, this path switch is transparent even to the Windows NT file system (NTFS). The combination of multiple paths and redundant hardware components provided by the HA/F200 offers significantly enhanced high availability over non-redundant configurations.

A single component failure in the HA/F200 will result in an automatic failover to an alternate component, allowing end users to continue accessing their applications without interruption. Some typical failures and associated responses in an HA/F200 configuration are:

- A server failure will cause MSCS to fail application processing over to the second server.
- A host bus adapter failure will cause I/O requests intended for the failed adapter to be re-routed through the remaining adapter.
- A storage hub, or cable, failure will be treated like a host bus adapter failure and a failover to the second host bus adapter, which is using a different storage hub and cables, will occur.
- An array controller failure will cause the redundant array controller to take over for the failed controller.

In all of the above examples, end users will experience minimal interruptions while the failover occurs. In some cases, the interruptions may not even be noticeable.

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The following illustration depicts the HA/F200 configuration components.

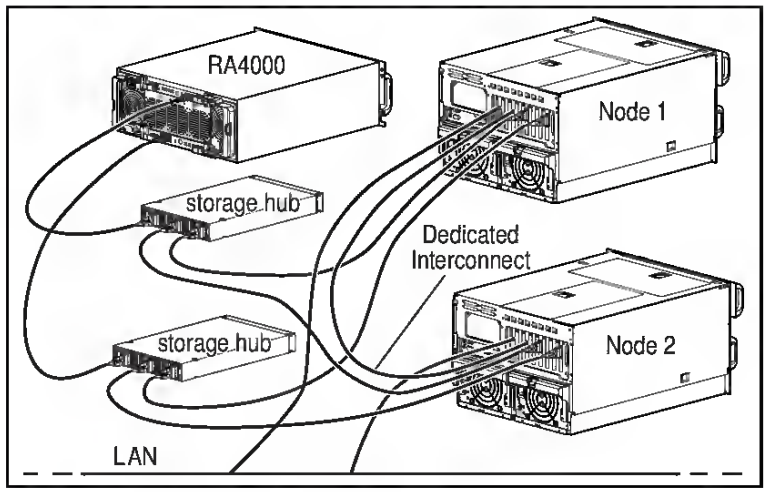

Figure 2-12. HA/F200 configuration

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HA/F200 Fibre Channel Data Paths

The Compaq StorageWorks RAID Array 4000 storage system is the mechanism with which the HA/F200 cluster implements shared storage. The Compaq ProLiant Cluster HA/F200 minimum configuration consists of two host bus adapters in each server, two 7- or 12-port storage hubs, two array controllers per RA4000, and one or more RA4000s.

The RA4000 storage system has active data paths and standby data paths, separated by two storage hubs. Figure 2-13 and Figure 2-14 detail the active and standby paths of the minimum HA/F200 configuration.

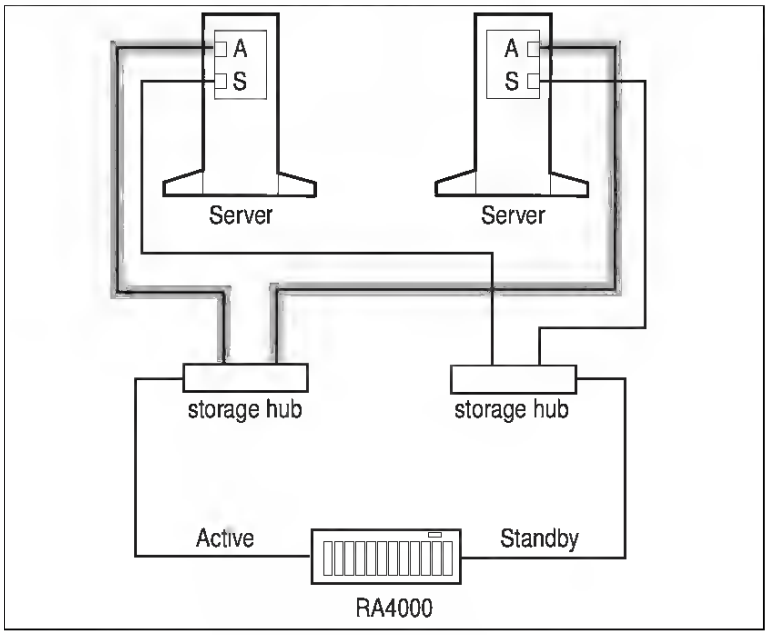

Figure 2-13. Active host bus adapter-to-storage data paths

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The active data paths run from the active host bus adapters in the servers to the active storage hub. If this path fails, the applications can seamlessly fail over to the standby host bus adapter-to-storage hub data paths.

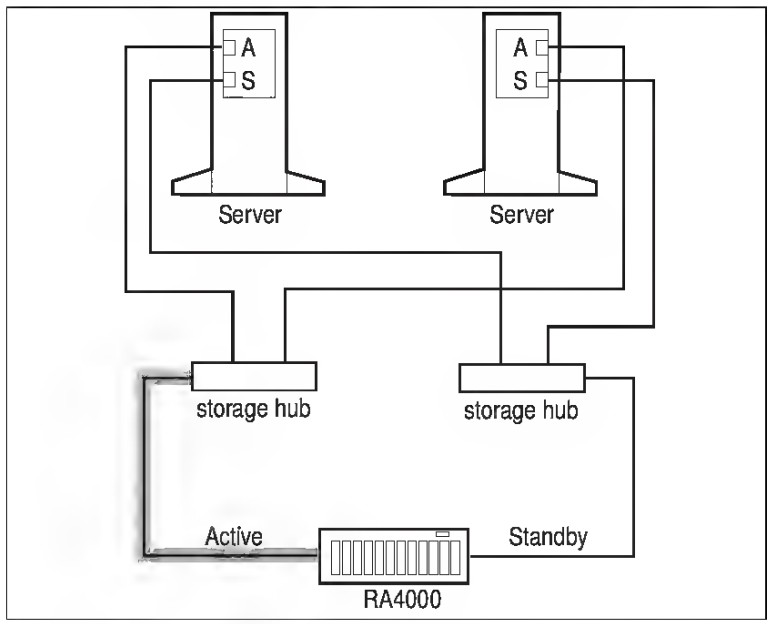

Figure 2-14. Active hub-to-storage data path

The second active data path runs from the active hub to the RA4000. If this path fails, the applications can seamlessly fail over to the standby hub-to-RA4000 data path.

The dual redundant loop feature of the Compaq ProLiant Cluster HA/F200 increases the level of availability over clusters that have only one path to the shared storage. In addition, the second loop in the HA/F200 provides for improved performance through load balancing. Load balancing considerations are discussed in the "Load Balancing" section of this chapter.

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Capacity Planning

Capacity planning determines how much computer hardware is needed to support the applications and data on your clustered servers. Unlike conventional, single-server capacity planning, clustered configurations must ensure that each node is capable of running any applications or services that may fail over from its partner node. To simplify the following discussion, the software running on each of the clustered nodes is divided into three generic categories:

- Operating system
- Nonclustered applications and services
- Clustered applications and services

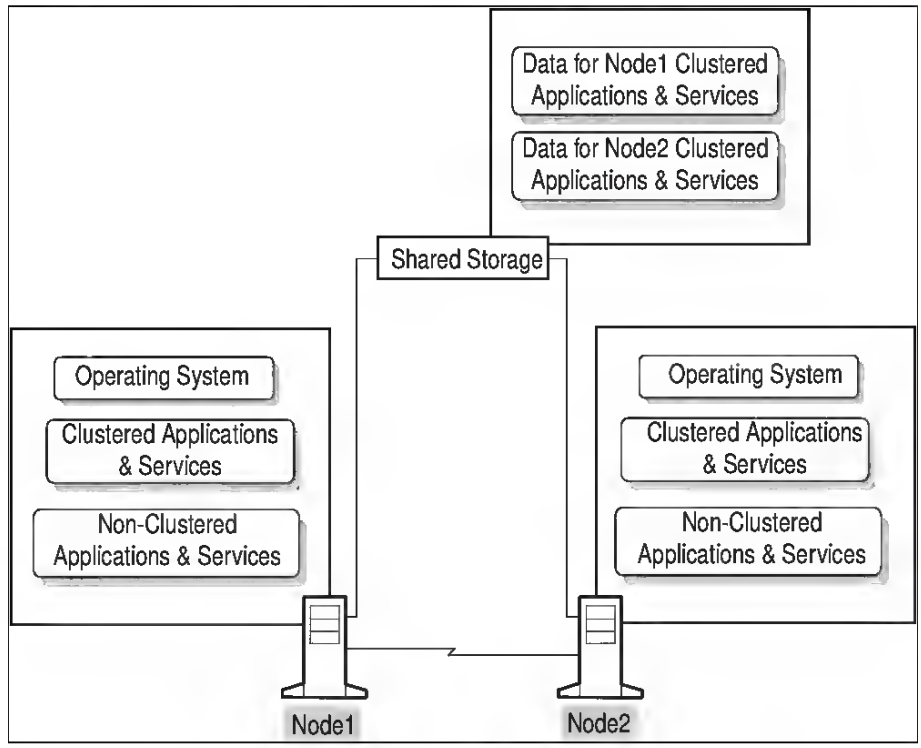

Figure 2-15. File locations in a Compaq ProLiant Cluster

For each server, determine the processor, memory, and disk storage requirements needed to support its operating system and nonclustered applications and services.

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Determine the processor and memory requirements needed to support the clustered applications and services that will run on each node while the cluster is in a normal operating state.

If the program files of a clustered application and/or service will reside on local storage, remember to add that capacity to the amount of local storage needed on each node.

For all files that will reside on shared storage, see "Shared Storage Capacity" later in this chapter.

Server Capacity

The capacity needed in each server depends on whether you design your cluster as an active/active configuration or as an active/standby configuration. Capacity planning for each configuration is discussed in the following sections.

Active/Active Configuration

As described earlier in this chapter, an active/active configuration can be designed in two ways:

- Applications and services may be configured to fail over from each node to its partner node, or
- Applications and services may be configured to fail over from just one node to its partner node.

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The following table details the capacity requirements that can be applied to either active/active design.

Table 2-1
Server Capacity* Requirements for Active/Active Configuration

Node1	Node2
Operating system (Windows NT and MSCS)	Operating system (Windows NT and MSCS)
Nonclustered applications and services	Nonclustered applications and services
Server1 clustered applications and services	Server2 clustered applications and services
Server2 clustered applications and services (if Server2 is set up to fail applications and services to Server1)	Server1 clustered applications and services (if Server1 is set up to fail applications and services to Server2)

* Processing power, memory, and nonshared storage

Active/Standby Configuration

In an active/standby configuration, only one node actively runs applications and services. The other node is in an idle, or standby, state. Assume Node1 is the active node and Node2 is the standby node.

Table 2-2
Server Capacity* Requirements for Active/Standby Configuration

Node1	Node2
Operating System (Windows NT and MSCS)	Operating system (Windows NT and MSCS)
Nonclustered applications and services	Server1 clustered applications and services
Server1 clustered applications and services	

* Processing power, memory, and nonshared storage

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Shared Storage Capacity

Each server is connected to shared storage (the Compaq StorageWorks RAID Array 4000 storage system), which mainly stores data files of clustered applications and services. Follow the guidelines below to determine how much capacity is needed for your shared storage.

> **NOTE:** For some clustered applications, it may make sense to store the application program files on shared storage. If the application allows customization and the customized information is stored in program files, the program files should be placed on shared storage. When a failover event occurs, the secondary node will launch the application from shared storage. The application will execute with the same customizations that existed when executed on the primary node.

Two factors help to determine the required amount of shared storage disk space:

- The amount of space required for all clustered applications and their dependencies.
- The level of data protection (RAID) required for each type of data used by each clustered application. Two factors driving RAID requirements are:
  - The performance required for each drive volume
  - The recovery time required for each drive volume

IMPORTANT: Windows NT software RAID is not available for shared drives when using MSCS. Hardware RAID is the only available RAID option for shared storage.

For more information about hardware RAID, see the following:

- *Compaq StorageWorks Fibre Channel RAID Array 4000 User Guide*
- Configuring Compaq RAID Technology for Database Servers (TechNote 184206-001), available at the Compaq website (http://www.compaq.com).

In the "Cluster Groups" section of this chapter, you created a resource dependency tree, then transferred that information into a Cluster Group Definition Worksheet (Figure 2-7). Under the resource dependencies in the worksheet, you listed at least one physical disk resource. For each physical disk resource, determine the capacity and level of protection required for the data to be stored on it.

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For example, the Web Sales Order Database group depends on a log file, data files, and program files. It might be important for the log file and program files to have a quick recovery time, while performance would be a secondary concern. Together, the files do not take up much capacity; therefore, mirroring (RAID 1) would be an efficient use of disk space and would fulfill the recovery and performance characteristics. The data files, however, would need excellent performance and excellent protection. The data files are expected to be large; therefore, a mirrored configuration would require an unacceptably expensive number of disk drives. To minimize the amount of physical capacity and still meet the performance and protection requirements, the data files would be configured to use Distributed Data Guarding (RAID 5).

Array Configuration

The Compaq Array Configuration Utility (ACU) is used to initially configure the array controller, reconfigure the array controller, add additional disk drives to an existing configuration, and expand capacity. The capacity expansion feature provides the ability to add storage capacity to a configured array without disturbing the existing data and to add a new physical drive to the array.

An array is created by grouping disk drives together to share a common RAID (Redundant Array of Inexpensive Disks) fault tolerance type. For example, in a single RA4000 storage system containing eight 18.2 GB drives, you could configure two of the drives in a RAID 1 mirrored array and the remaining six drives as a RAID 5 Distributed Data Guarding array.

Each array must be divided into at least one volume (up to a maximum of eight volumes per array). Each volume is presented to the operating system as an independent disk drive and can be independently controlled by the cluster software. Using the previous example, you could configure the two-drive RAID 1 array as a single volume (for example, drive F), and the six-drive RAID 5 array as two volumes (for example, drives G and H). Because the operating system views these as independent disks, it is possible for cluster Node1 to control drive G, while cluster Node2 controls drives F and H.

More information regarding cluster disk configuration can be found in the Compaq TechNote, Planning Considerations for Compaq ProLiant Clusters Using Microsoft Cluster Server, located on the Compaq website (http://www.compaq.com).

This capability provides a high level of flexibility in configuring your RA4000 storage system. However, minimize the number of volumes configured in each array to improve performance. To achieve optimal performance, each array should contain a single volume. In some cases (such as for the MSCS quorum drive), it may be desirable to add a second, smaller volume to an array.

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Shared Storage Capacity Worksheet

The following Shared Storage Capacity worksheet will assist in determining your shared storage capacity requirements. The following example illustrates the required shared storage capacity for the entire Web Sales Order business function. A blank worksheet is provided in Appendix A.

Shared Storage Capacity Worksheet		
	Disk Resource 1	**Disk Resource 2**
Description	Web files and Web scripts for Web Service Group	Log file(s) for Database
Required Application Capacity	12 GB	4.3 GB
Desired Level of Protection	RAID 5	RAID 1
RAID Configuration	4 x 4.3 GB	2 x 4.3 GB
Required Capacity With RAID	17.2 GB	8.6 GB
Total Usable Capacity	12.9 GB	4.3 GB
	Disk Resource 3	**Disk Resource 4**
Description	Data file(s) for Database	N/A
Required Application Capacity	27 GB	
Desired Level of Protection	RAID 5	
RAID Configuration	4 x 9.0 GB	
Required Capacity With RAID	36 GB	
Total Usable Capacity	27 GB	
	Disk Resource 5	**Disk Resource 6**
Description	N/A	N/A
Required Capacity Without RAID		
Desired Level of Protection		
RAID Configuration		
Required Capacity With RAID		
Total Usable Capacity		

Figure 2-16. Shared Storage Capacity Worksheet (example)

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Load Balancing

Load balancing helps to attain enhanced performance from the cluster by balancing the system's workload. With cluster configurations, applications and data can be shared by all components so that no one component is working at its maximum capability.

There are two means of load balancing. One way balances a system's workload across the cluster. The other balances a server's workload across multiple data paths. The dual redundant loop of the Compaq ProLiant Cluster HA/F200 and an added RA4000 storage system spread a system's applications and data across the data paths through an active/active host bus adapter. This configuration can increase the functionality of the cluster.

IMPORTANT: Disk load balancing cannot be done when using a single RA4000 in a Compaq ProLiant Cluster HA/F200. Add another RA4000 to your HA/F200 configuration for host bus adapters in a single server to be active/active

Figure 2-17 shows a Compaq ProLiant Cluster HA/F200 configuration with only one RA4000. Because there is only one RA4000, the host bus adapters are in active/standby mode, which means that they do not have load-balancing capability.

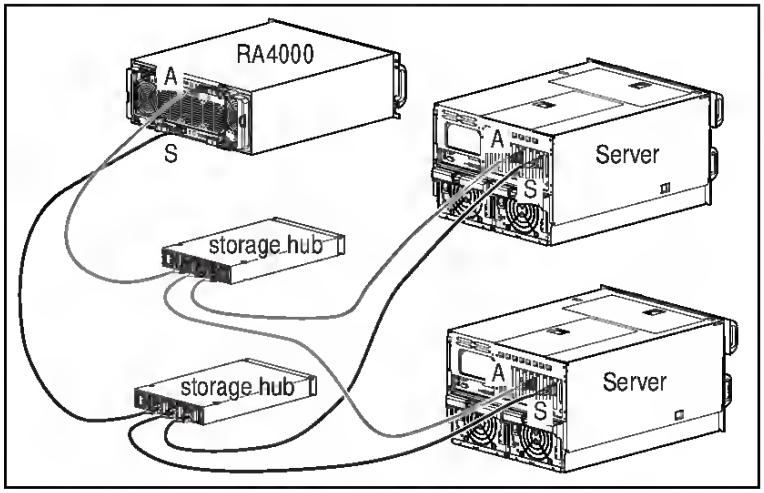

Figure 2-17. Compaq ProLiant Cluster HA/F200 with one RA4000

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Figure 2-18 depicts a Compaq ProLiant Cluster HA/F200 with dual RA4000s. This configuration can accommodate load balancing because the host bus adapters are in active/active mode to different storage systems.

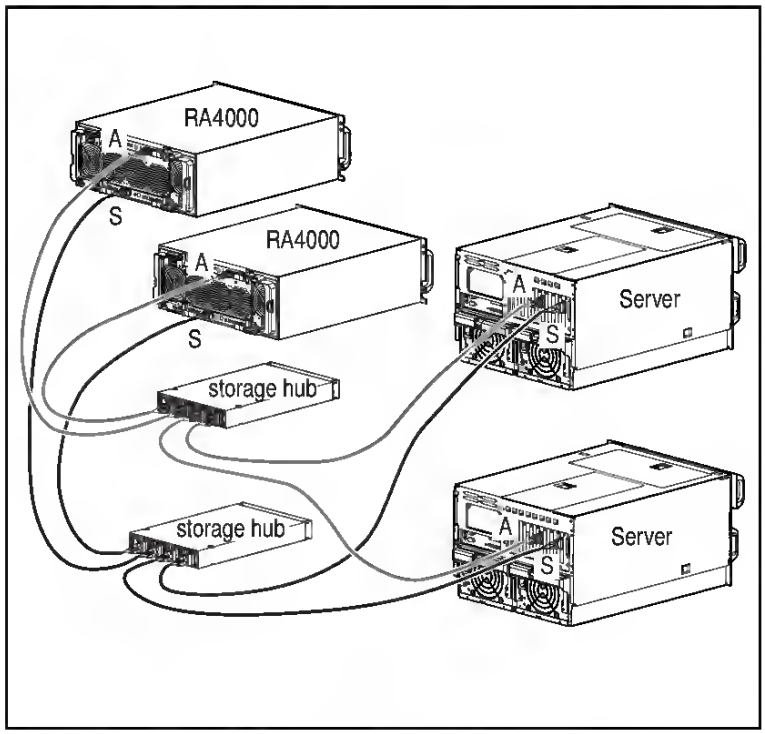

Figure 2-18. Compaq ProLiant Cluster HA/F200 with dual RA4000s

Networking Capacity

The final capacity planning section addresses networking. The cluster nodes must have enough network capacity to handle requests from the client machines and must gracefully handle failover/failback events.

Make sure both nodes can handle the maximum number of clients that can attach to the cluster. If Node1 encounters a failure and its applications and services fail over to Node2, then Node2 needs to handle access from its own network clients as well as those that normally connect to the failed node (Node1).

Note the effect of failover on network I/O bandwidth. When the cluster encounters a server failover event, only one node is responding to network I/O requests. Be sure the surviving node's network speed and protocol will sufficiently handle the maximum number of network I/Os when the cluster is running in a degraded state.

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Network Considerations

This section addresses clustering items that affect the corporate LAN. MSCS has specific requirements regarding which protocol can be used and how IP address and network name resolution occurs. Additionally, consider how network clients will interact within a clustering environment. Some client-side applications may need modification to receive the maximum availability benefits of operating a cluster.

Network Configuration

Network Protocols

TCP/IP and NBT (NetBIOS over TCP/IP) are the only transport protocols that are supported in an MSCS failover environment. Other protocols, such as NetBEUI, IPX/SPX (Novell), NB/IPX, or DLC (IBM) may be used, but they cannot take advantage of the failover features of MSCS.

Applications that use these other protocols will function identically to a single-server environment. Users can still use these protocols, but they will connect directly to the individual servers and not to the virtual servers on the cluster, just as in a single-server environment. If a failure occurs, any connections using these protocols will not switch over. Since these protocols cannot fail over to another server, avoid these protocols, if possible.

WINS and DNS

WINS (Windows Internet Name Service) and DNS (Domain Name Service) are supported in MSCS. Use WINS to register the network names and IP addresses of cluster resources. If WINS is not used, create an entry in the *hosts* or *lmhosts* file that lists each network name and IP address pair, as well as the cluster name and its IP, address since these function as virtual servers to the clients.

If clients are located on a different subnet than the cluster nodes, modify the DNS database to add a DNS address record for the cluster.

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DHCP

Only use DHCP for the clients; it should not be used for the cluster node IP addresses or cluster resource IP addresses. DHCP cannot be used to assign IP addresses for virtual servers.

When configuring DHCP, exclude enough static IP addresses from the pool of dynamically leased addresses to account for the following:

- Cluster node IP addresses
- At least one static IP address for each virtual server

Migrating Network Clients

One of the first steps in assessing the impact of a clustered environment on the network clients is to identify the various types of network functions and applications that are provided to the users. It is likely that several steps are necessary to migrate your clients to take full advantage of clustering.

File and Print Services

The main consideration for file and print services is the method clients use to connect to the shared resources. If clients use batch files to connect to shared directories on the server, the batch files may need to be updated to reflect the new path name and, possibly, the new share name.

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Connecting to Shared Resources

In the traditional, command-driven connection to a shared resource, the user needs to know the server name and the share name. In a clustered environment, the command is changed to reflect the cluster network name and file share that were configured as part of the failover group for that shared directory.

Compare the command syntax in Table 2-3 for connecting to a shared resource on a stand-alone server versus a clustered server.

Table 2-3
Comparison of Net Use Command Syntax

Server Environment	Command Syntax
Stand-alone server	Net use J:\\servername\sharename
Cluster node	Net use J:\\networkname\fileshare

Change client login scripts and profiles so that users connect to resources using the cluster network name and file share.

Client/Server Applications

Reconfiguration of client applications in a client/server environment may also be required. Some applications, such as many of the popular databases, require the client to specify the IP address of the server that holds the database they want to connect to. The IP addresses may be held in a special configuration program or in a text file. Any references to the server's actual IP addresses must be changed to reflect the new IP Address Resource that has been configured for that application's cluster group.

Some databases allow you to specify the IP address of a backup server, which the client database software attempts to use in case the database is not accessible using the first IP address. The backup IP address scheme can be used in a nonclustered environment to assist clients if the primary server fails. This is no longer necessary when using MSCS.

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In a clustered environment, IP addresses for the database are configured to fail over with the database application, making a backup IP address on the client unnecessary. When the database resources have failed over to the other server, the client can reconnect to the database using the same IP address as before the failure. This process may be automated if the client application software supports automatic connection retries.

IMPORTANT: Examine these client configuration issues in a pilot and testing phase before implementing a clustered system. This will help you to identify any client reconfiguration requirements and understand how client applications will behave in a clustered environment, especially after a failure.

Failover/Failback Planning

The final section of this chapter addresses several factors to consider when planning for failover and failback events.

- Performance of clustered servers after failover
- Cluster server thresholds and periods
- Failover of directly connected devices
- Automatic vs. manual failover
- Failover/failback policies

Performance After Failover

As applications or resources fail from one server to another, the performance of the clustered servers may change dynamically. This is especially obvious after a server failure, when all of the cluster resources may move to the other cluster node.

Performance monitoring of server loads after a failure should be investigated prior to a full clustered system implementation. You may need additional hardware, such as memory or system processors, to support the additional workload incurred after a failover.

It is also important to understand the performance impact when configuring server pairs in a failover cluster. If a business-critical database is already running at peak performance, requiring the server to take on the additional workload of a failed server may adversely affect business operations. In some cases, you may find it appropriate to pair that server with a low-load server, or even with a no-load server (as in an active/standby cluster configuration).

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You can use the Windows NT Performance Monitor to observe and track system performance. Some applications may also have their own internal performance measurement capabilities.

MSCS Thresholds and Periods

MSCS offers flexibility in configuring the initiation of failover events. For resources, MSCS allows you to set Restart Thresholds and Periods. For cluster groups, MSCS allows you to set Failover Thresholds and Periods.

Restart Threshold and Restart Period

A restart threshold defines the maximum number of times per restart period that MSCS attempts to restart a resource before failing over the resource and its corresponding cluster group. See the following example:

Assume you have a disk resource (Disk1) that is part of a cluster group (Group1). You set the restart threshold to 5 and the restart period to 10. If the Disk1 resource fails, MSCS will attempt to restart the resource on the group's current cluster node five times within a 10-minute period. If the resource cannot be brought online within the 10-minute restart period, then Group1 will fail over to the partner cluster node.

Note that MSCS waits the length of the restart period (for example, 10 minutes) before actually failing over the cluster group. You must assess the likelihood that the group will successfully restart on its present node against the time required to restart the cluster group before failing it over. If it is appropriate to immediately fail over any group that encounters a problem, set the restart threshold to 0 (zero). If the group will experience severe performance limitations if failed over to a secondary server, set the threshold and period so that MSCS attempts to restart the group on its preferred server.

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Failover Threshold and Failover Period

The failover threshold and failover period are similar to the restart values. The failover threshold defines the maximum number of times per failover period that MSCS attempts to fail over a cluster group. If the cluster group exceeds the failover threshold in the allotted failover period, the group is left on its current node, in its current state, whether that is online, offline, or partially online.

The failover threshold and failover period prevents a cluster group from bouncing back and forth between servers. If a cluster group is so unstable that it cannot run properly on either cluster node, it will eventually be left in its current state on one of the nodes. The failover threshold and period determine the point at which the decision is made to leave the cluster group in its current state.

The following example illustrates the relationship between the restart threshold and period and the failover threshold and period.

Assume you have a cluster group (Group1) that is configured to have a preferred server (Server1). If Group1 encounters an event that forces it offline, MSCS attempts to restart the resource. If Group1 cannot be restarted within the limits of the restart threshold and period, MSCS attempts to fail over Group1 to Node2. lf the failover threshold for Group1 is set to 10 and the failover period is set to 3 (hours), MSCS will fail over Group1 as many as 10 times in a 3-hour period. If a failure is still forcing Group1 offline after three hours, MSCS will no longer attempt to fail over the group.

Failover of Directly Connected Devices

Devices that are physically connected to a server cannot move to the other cluster node. Therefore, any applications or resources dependent on these devices may be unable to restart on the other cluster node. Examples of direct-connect devices include printers, mainframe interfaces, modems, fax interfaces, and customized input devices such as bank card readers.

For example, if a server is providing print services to users, and the printer is directly connected to the parallel port of the server, there is no way to switch the physical connection to the other server, even though the print queue and spooler can be configured to fail over. The printer should be configured as a true network printer and connected to a hub that is accessible from either cluster node. In the event of a server failure, not only will the print queue and spooler fail over to the other server, but physical access to the printer will be maintained.

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Another example of a direct-connect device is a directly connected mainframe interface. If the first server is directly connected to the mainframe, as through an SDLC (Synchronous Data Link Control) card in the server, there is no way to switch the physical connection to a second server. In a case like this, you may be able to use the client network to access the mainframe using TCP/IP. Since TCP/IP addresses can be configured to fail over, you may be able to reestablish the connection after a switch. However, many mainframe connectivity applications use the Media Access Control (MAC) address that is burned into the NIC to communicate with the server. This would cause a problem because MAC addresses cannot be configured to fail over.

Carefully examine the direct-connect devices on each server to determine whether you need to provide alternate solutions outside of what the cluster hardware and software can accomplish. These devices can be considered single points of failure because the cluster components may not be able to provide failover capabilities for them.

Manual vs. Automatic Failback

Failback is the act of integrating a failed cluster node back into the cluster. Specifically, it brings cluster groups and resources back to their preferred server. MSCS offers automatic and manual failback options. The automatic failback event will occur whenever the preferred server is reintegrated into the cluster. If the reintegration occurs during normal business hours, there may be a slight interruption in service for network clients during the failback process. If the interruption needs to occur in nonpeak hours, be sure to set the failback policy to "Allow" and set the "Between Hours" settings to acceptable values. For full control over when a cluster node is reintegrated, use manual failback by choosing "Prevent" as the failback policy.

Many organizations prefer to use manual failback for business-critical clusters. This prevents applications from automatically failing back to a server that has failed, automatically rebooted, and automatically rejoined the cluster before the root cause of the original error has been determined.

These terms are described and illustrated in the Group Failover/Failback Policy Worksheet provided in the following section.

Failover and Failback Policies

In the "Cluster Groups" section of this chapter, you created one or more cluster group definition worksheets (Figure 2-7). For each cluster group defined in the worksheets, you will now determine its failover and failback policies by filling in the Group Failover/Failback Policy worksheet.

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Terms and Definitions

The following terms and definitions are used in defining failover/failback policies for cluster groups.

Table 2-4
Group Failover/Failback Policy Terms and Definitions

Term	Definition
Failover policy	The circumstances MSCS uses to take a group offline on the primary (preferred) node and online on the secondary node.
Failback policy	The circumstances MSCS uses to bring a group offline on the secondary node and online on the primary (preferred) node.
Preferred owner	The cluster node you want the cluster group to run on when the cluster is in a normal state.
Failover threshold	The number of times MSCS will attempt to fail over a group within a specified failover period.
Failover period	The length of time in which MSCS attempts to fail over a cluster group. When the failover threshold count has been exceeded within the failover period, MSCS leaves the group on its current node, in its current state. Example: If the failover threshold = 5 and the failover period = 1, MSCS will attempt to fail over the group 5 times within a 1-hour period.
Prevent	Prevent automatic failback. This setting allows the administrator to fail back a group manually.
Allow	Allow automatic failback. This setting allows MSCS to fail back a group automatically.
Allow immediately	This setting allows automatic failback as soon as the preferred node is reintegrated into the cluster and brought back online.
Allow between hours	This setting allows the administrator to determine specific hours of the day during which automatic failback can occur.

Refer to the *Microsoft Cluster Server Administrator's Guide* for detailed information about failover and failback policies of groups and resources.

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Group Failover/Failback Policy

Use the Group Failover/Failback Policy worksheet to define the failover and failback policies for each cluster group. Figure 2-19 illustrates the failover/failback parameters for the Web Server Service of the Web Sales Order business function defined in previous examples. A blank copy of the worksheet is provided in Appendix A.

<table>
<tr><th colspan="4">Group Failover/Failback Policy Worksheet</th></tr>
<tr><td>Group Name</td><td colspan="3">Web Server Service</td></tr>
<tr><th colspan="4">General Properties</th></tr>
<tr><td>Name</td><td colspan="3">Web Server Service</td></tr>
<tr><td>Description</td><td colspan="3">Group containing Web Server Service used to operate the Web Sales Order business function</td></tr>
<tr><td>Preferred Owners</td><td colspan="3">Server 1</td></tr>
<tr><th colspan="4">Failover Properties</th></tr>
<tr><td>Threshold</td><td colspan="3">5</td></tr>
<tr><td>Period</td><td colspan="3">10</td></tr>
<tr><th colspan="4">Failback Properties</th></tr>
<tr><td rowspan="4">☑ Prevent
(manual failback preferred for this group)</td><td colspan="3">☐ Allow</td></tr>
<tr><td colspan="3">Choose one:</td></tr>
<tr><td>☐ Immediately</td><td colspan="2">☐ Between hours</td></tr>
<tr><td></td><td>Start</td><td>End</td></tr>
</table>

Figure 2-19. Group Failover/Failback Policy Worksheet (example)

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Chapter 3

Setting Up the Compaq ProLiant Clusters HA/F100 and HA/F200

Preinstallation Overview

This chapter provides instructions for building a new Compaq ProLiant Cluster HA/F100 or a Compaq ProLiant Cluster HA/F200.

If you already have an HA/F100 and you wish upgrade to an HA/F200 configuration, turn to Chapter 4. If you begin with Chapter 4, be sufficiently familiar with the guidelines outlined at the beginning of Chapter 3, which will help to ensure that the configuration is properly set up. Chapter 4 assumes you are familiar with the HA/F100 configuration hardware and software.

The Compaq ProLiant Clusters HA/F100 and HA/F200 are combinations of several individually available products. Have the following documents available as you set up your cluster.

- Documentation for the clustered Compaq ProLiant Servers
- *Compaq StorageWorks RAID Array 4000 User Guide*
- *Compaq StorageWorks Fibre Channel Host Adapter Installation Guide*
- Installation guide for the interconnect card of your choice
- Compaq SmartStart for Servers Setup Poster
- Compaq Insight Manager Installation Poster

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- *Compaq Intelligent Cluster Administrator Quick Setup Guide*
- *Microsoft Windows NT Server 4.0/Enterprise Edition Administrator's Guide*
- *Microsoft Cluster Server Administrator's Guide*

The installation and setup of your ProLiant Cluster can be described in the following phases:

- Preinstallation guidelines
- Installing the hardware, including:
  - Cluster nodes
  - Compaq StorageWorks RAID Array 4000 storage system
  - Cluster Interconnect
- Installing the software, including:
  - Compaq SmartStart for Servers
  - Compaq Redundancy Manager (Fibre Channel)
  - Microsoft Windows NT Server 4.0/Enterprise Edition
  - Compaq Insight Manager (optional)
  - Compaq Insight Manager XE (optional)
  - Compaq Intelligent Cluster Administrator (optional)
- Additional Cluster Verification Steps, including:
  - Verifying creation of the cluster
  - Verifying node failover
  - Verifying network client failover

These installation and configuration steps are described in the following pages.

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Preinstallation Guidelines

When setting up the cluster, you will need to answer each of the following questions. Using the Preinstallation Worksheet in Appendix A, write down the answers to these questions before installing Microsoft Cluster Server (MSCS) on either cluster node.

- Are you forming or joining a cluster?
- What is the cluster name?
- What are the username, password, and domain for the domain account that MSCS will run under?
- What disks will you use for shared storage?
- Which shared disk will you use to store permanent cluster files?
- What are the adapter names and IP addresses of the network adapter cards you will use for client access to the cluster?
- What are the adapter names and IP addresses of the network adapter cards you will use for the private interconnect between the cluster nodes?
- What is the IP address and subnet mask of the address you will use to administer the cluster?

Installing clustering software requires several specific steps and guidelines that may not be necessary when installing software on a single server. Read and understand the following items before proceeding with any software installation:

- Have sufficient software licensing rights to install Windows NTS/E and software applications on each server because a cluster configuration uses more than one server.
- Install clustering hardware before installing the software.
- The storage hub must have AC power.
- The RA4000 storage system must be turned on before the cluster nodes are powered on.

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- Log on to the domain using an account that has administrative permissions on both cluster nodes. When installing MSCS, both cluster nodes must be in the same Windows NT domain. The cluster nodes can be members of an existing Windows NT domain, they can both be member servers, they can make up their own domain by assigning one as Primary Domain Controller (PDC) and one as Backup Domain Controller (BDC), or they can both be a BDC in an existing Windows NT domain.

- One of the utilities the SmartStart CD runs is the Compaq Array Configuration Utility, which configures the drives in the RA4000. The Array Configuration Utility stores the drive configuration information on the drives themselves. After you have configured the shared drives from one of the cluster nodes it is not necessary to configure the drives from the other cluster node.

  When the Array Configuration Utility runs on the first cluster node, configure the shared drives in the RA4000 storage system. When SmartStart runs the utility on the second cluster node, you will be presented the information on the shared drives that was entered when the Array Configuration Utility was run on the first node. Accept the information as presented and continue.

- For a manual software installation, use Windows NT Disk Administrator on the first cluster node to configure the shared drives, and allow MSCS to synchronize information between the two nodes.

  By running Disk Administrator from the first node, you prevent potential problems caused by inconsistent drive configurations. When the second cluster node joins the cluster, the disk information in the Windows NT Registry is copied from the first node to the second node.

- Only New Technology File System (NTFS) is supported on shared drives.

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- MSCS requires drive letters to remain constant throughout the life of the cluster; therefore, you must assign permanent drive letters to your shared drives. If you are performing manual software installation, use Windows NT Disk Administrator to assign drive letters and ensure the assignments are permanent.

  Windows NT makes dynamic drive letter assignments (when drives are added or removed, or when the boot order of drive controllers is changed), but Windows NT Disk Administrator allows you to make permanent drive letter assignments.

  NOTE: This step does not apply if you are using the SmartStart Assisted Integration installation.

- Cluster nodes can be members of only one cluster.

  NOTE: It is possible to use hosts and LMHosts files, as well as DNS (Domain Name Server), for intracluster communication. However, WINS is the recommended method.

- When you set up the cluster interconnect, select TCP/IP as the network protocol. MSCS requires the TCP/IP protocol. The cluster interconnect must be on its own subnet. The IP addresses of the interconnects must be static, not dynamically assigned by DHCP.

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Installing the Hardware

The following installation steps detail setting up a Compaq ProLiant Cluster HA/F100 or HA/F200.

Setting Up the Nodes

Physically preparing the nodes (servers) for use in a cluster is not very different from preparing them for individual use. The primary difference will be setting up the shared storage:

1. Install all necessary adapter cards and insert all internal hard drives.
2. Attach network cables and plug in SCSI and/or Fibre Channel cables.
3. Set up one node completely, then set up the second node.

IMPORTANT: Do not load any software on either cluster node until all the hardware has been installed in both cluster nodes.

NOTE: Compaq recommends that Automatic Server Recovery (ASR) be left at the default values for clustered servers.

Follow the installation instructions in your Compaq ProLiant Server documentation to set up the hardware. To install Compaq StorageWorks Fibre Channel Host Adapters (host bus adapters) and any interconnect cards, follow the instructions in the next sections.

IMPORTANT: For the most up-to-date list of cluster-certified servers, access the Compaq High Availability website (http://www.compaq.com/highavailability).

Installing the Compaq StorageWorks Fibre Channel Host Adapter

Follow the installation instructions in your *Compaq StorageWorks Fibre Channel Host Adapter Installation Guide* and your Compaq ProLiant Server documentation to install the host bus adapter in your servers. Install one adapter per server for the HA/F100 configuration. Install two adapters per server for the HA/F200 configuration.

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The host bus adapters, which connect the two servers to the storage through storage hubs, are installed in each server like any other PCI card. The HA/F100 cluster requires *one* host bus adapter per server, while the HA/F200 requires *two* host bus adapters per server. The extra host bus adapter in each server contributes to the enhanced high availability features of the HA/F200. The dual host bus adapters, in conjunction with dual hubs and dual array controllers form two completely independent paths to the storage, making the server-to-storage connection totally redundant. However, it is important to ensure that each host bus adapter in a particular server is connected to a different hub, because it is physically possible to connect the servers to the storage hubs is such a way that the cluster will appear to be working correctly, but will not be able to fail over properly.

NOTE: To determine the preferred slots for installing the host bus adapters, use PCI bus-loading techniques to balance the PCI bus tor your hardware and configuration. For more information, refer to your server documentation, Performance and Tuning TechNotes, and the Compaq White Paper, "Where Do I Plug the Cable? Solving the Logical-Physical Slot Numbering Problem," available trom the Compaq website (http://www.compaq.com).

Installing the Cluster Interconnect

There are many ways to physically set up an interconnect. Chapter 1 discusses the various types of interconnect strategies.

If you are using a dedicated interconnect, install an interconnect adapter card (Ethernet or ServerNet) in each cluster node if you are using a dedicated interconnect. If you are sharing your local area network (LAN) network interface card (NIC) with your interconnect, install the LAN NIC.

NOTE: To determine the preferred slot for installing the interconnect card, use PCI bus-loading techniques to balance the PCI bus tor your hardware and configuration. If you are installing the ServerNet card, treat it as a NIC in determining the preferred installation slot for maximum performance. For more information, see your server documentation, Pertormance and Tuning TechNotes, and the Compaq White Paper, "Where Do I Plug the Cable? Solving the Logical-Physical Slot Numbering Problem," available from the Compaq website (http://www.compaq.com).

For specific instructions on how to install an adapter card, refer to the documentation for the interconnect card you are installing or the Compaq ProLiant Server you are using. The cabling of interconnects is outlined later in this chapter.

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Setting Up the Compaq StorageWorks Raid Array 4000 Storage System

Follow the instructions in the *Compaq StorageWorks RAID Array 4000 User Guide* to set up the RA4000s, the Compaq StorageWorks Fibre Channel Storage Hub 7 or 12, the Compaq StorageWorks RA4000 Controller (array controller), and the Fibre Channel cables.

Note that the *Compaq StorageWorks RAID Array 4000 User Guide* explains how to install these devices for a single server. Because clustering requires shared storage, you will need to install these devices for two servers. This will require running an extra Fibre Channel cable from the storage hub to the second server.

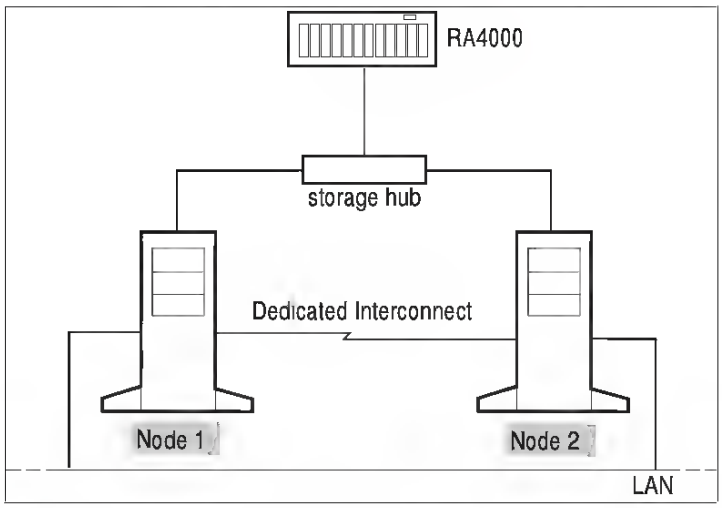

Figure 3-1. RA4000 storage system connected to clustered servers in the HA/F100 configuration

IMPORTANT: It is strongly recommended for cluster configuration that all shared drives be in the storage box before running the Compaq Array Configuration Utility.

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Powering Up

Before applying power to the RA4000, all components must be installed and connected to the storage hub. Hard drives should be installed in the RA4000 so they can be identified and configured.

The cluster must be powered up in the following order:

1. Storage hub (Power is applied when the AC power cord is plugged in)
2. Storage system
3. Servers

Configuring Shared Storage

The Compaq Array Configuration Utility sets up the hardware aspects of any drives attached to an array controller, including the drives in the shared RA4000s. The Array Configuration Utility can initially configure the array controller, reconfigure the array controller, add additional disk drives to an existing configuration, and expand capacity. The Array Configuration Utility stores the drive configuration information on the drives themselves; therefore, after you have configured the drives from one of the cluster nodes, it is not necessary to configure the drives from the other cluster node.

For detailed information about configuring the drives, refer to "Running the Array Configuration Utility" in the *Compaq StorageWorks RAID Array 4000 User Guide*.

The Array Configuration Utility runs automatically during an Automated SmartStart cluster installation.

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Setting Up a Private Interconnect

There are four ways to set up a private interconnect.

- Ethernet direct connect
- Ethernet direct connect using a private hub
- ServerNet direct connect
- ServerNet direct connect using a switch

Ethernet Direct Connect

An Ethernet crossover cable is included with your Compaq ProLiant Cluster. This cable directly connects two Ethernet cards. Place one end of the cable in the interconnect (Ethernet) card in Node1 and the other end of the cable in the interconnect card in Node2.

IMPORTANT: Place the cable into the interconnect cards and not into the Ethernet connections used for the network clients (the LAN).

NOTE: The crossover cable will not work in conjunction with a storage hub.

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Ethernet Direct Connect Using a Private Hub

An Ethernet hub requires standard Ethernet cables; Ethernet crossover cables will not work with a hub. Follow these steps to cable the server interconnect using an Ethernet hub:

1. Connect the end of one of the Ethernet cables to the interconnect (Ethernet) card in Node1.
2. Connect the other end of the cable to a port in the hub.
3. Repeat steps 1 and 2 for the interconnect card in Node2.

IMPORTANT: Place the cable into the interconnect cards and not into the Ethernet connections used for the network clients (the LAN).

ServerNet Direct Connect

If you have chosen the Compaq ServerNet option as the server interconnect for your ProLiant Cluster, you will need the following:

- Two ServerNet PCI adapter cards
- Two ServerNet cables

Follow these steps to install the ServerNet interconnect:

1. Connect one end of a ServerNet cable to connector *X* on the ServerNet card in Node1.
2. Connect the other end of the ServerNet cable to connector *X* on the ServerNet card in Node2.
3. Connect the two ends of the second ServerNet cable to the *Y* connectors on the ServerNet cards in Node1 and Node2.

IMPORTANT: Fasten the cable screws tightly. A loose cable could cause an unexpected fault in the interconnect path and potentially cause an unnecessary tailover event.

ServerNet Direct Connect Using a Switch

Although not necessary for a two-node cluster, the use of a ServerNet Switch allows for future growth. Refer to the Compaq ServerNet documentation for a description and detailed installation instructions.

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Setting Up a Public Interconnect

It is possible—but not recommended—to use a public network as your dedicated interconnect path. To set up a public Ethernet interconnect, connect the Ethernet cards, hub, and cables as you would in a nonclustered environment. Then configure the Ethernet cards for both network clients and for the cluster interconnect.

IMPORTANT: Using a public network as your dedicated interconnect path is not recommended because it represents a potential single point of failure for cluster communication.

NOTE: ServerNet is designed to be used only as a private or dedicated interconnect. It cannot be used as a public interconnect.

Redundant Interconnect

MSCS allows you to configure any certified network card as a possible path for intracluster communication. If you are employing a dedicated interconnect, use MSCS to configure your LAN network cards to serve as a backup for your interconnect.

See the "Recommended Cluster Communication Strategy" section in Chapter 2 of this guide for more information about setting up redundancy for intracluster and cluster-to-LAN communication.

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Installing the Software

The following information describes the software installation steps for the HA/F100 and the HA/F200. Proceed with these steps once you have all equipment installed and your hubs, storage system, and one server powered up.

You need the following during installation:

IMPORTANT: Refer to Appendix C for the software and firmware version levels your cluster requires.

- Compaq SmartStart for the Servers CD
- Compaq SmartStart for Servers Setup Poster
- Server Profile Diskette (included with SmartStart)
- Microsoft Windows NT Server 4.0/Enterprise Edition software and documentation
- Compaq Redundancy Manager (Fibre Channel) software
- Monitoring and Management Software
  - Compaq Insight Manager software and documentation
  - Compaq Insight Manager XE software and documentation
  - Compaq Intelligent Cluster Administrator software and documentation
- At least ten high-density diskettes
- Windows NT 4.0 Service Packs

Assisted Integration Using SmartStart (Recommended)

Use the SmartStart Assisted Integration procedure to configure the servers (nodes) in the HA/F100 and HA/F200 configuration. You will set up two nodes during this process. Go through all steps on each of the nodes with noted exceptions. The following steps will take you through the SmartStart Assisted Integration procedure.

CAUTION: Installation using SmartStart assumes that SmartStart is being installed on new servers. Any existing data on the servers' boot drive will be erased.

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Cluster-Specific SmartStart Installation

The SmartStart setup poster describes the general flow of configuring and installing software on a single server. The installation for a Compaq ProLiant Cluster HA/F100 and HA/F200 will be very similar. The difference between running SmartStart on a stand-alone server and running SmartStart for a cluster are noted below:

- Through the Compaq Array Configuration Utility, you can configure the shared drives on both servers. For cluster configuration, configure the drives on the first server, then accept the same settings for the shared drives when given the option on the second server.
- When configuring drives through the Array Configuration Utility, create a logical drive with 100MB of space to be used as the quorum disk.

Assisted Installation Steps

IMPORTANT: Power off Node2 when setting up Node1.

1. Power on the shared storage. Place the SmartStart CD in the CD-ROM drive of the cluster node and power on the node. The CD will automatically run.
2. Select the **Assisted Integration** installation path.
   Follow steps outlined in the SmartStart Setup Poster. Noted below are some steps specific to configuring a server for use in the HA/F100 and HA/F200.
3. When SmartStart prompts for the operating system, select **Microsoft Windows NT Server 4.0/Enterprise Edition (Retail)** or **Microsoft Windows NT Server 4.0/Enterprise Edition (Select)** as the operating system. The edition of Windows NT that you select will be determined by the version of the software you have.
4. After the hardware configuration has run, restart the computer.
5. When you restart the computer, SmartStart will automatically run the Array Configuration Utility. Choose the custom configuration option to create RAID sets on your RA4000 storage system. Refer to the *Compaq StorageWorks RAID Array 4000 User Guide* for more details.

IMPORTANT: Node2 Exception: When configuring Node2, the Array Configuration Utility shows the results of the shared drives configured during Node1 setup. Accept these changes for Node2 by exiting.

NOTE: Create a logical drive with 100MB of space to be used as the quorum disk.

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6. After you have completed using the Array Configuration Utility, the system will reboot and SmartStart will automatically create your system partition.
7. Next, you will be guided through steps to install addition Compaq software and utilities including choosing the NT boot partition size and installing the Compaq Support Software Disk (SSD). Follow the instructions in the SmartStart setup poster.

IMPORTANT: Node2 Exception: When configuring Node2, exit out of the Diskette Builder Utility and go to step 9.

---

8. After the Diskette Builder Utility has loaded, create the Options ROMPaq utility in Diskette Builder. Label the diskettes you create. The Options ROMPaq utility updates the firmware on the array controllers and the hard drives. For more information about Options ROMPaq, refer to the *Compaq StorageWorks RAID Array 4000 User Guide*. You can also create the SSD during this process.
9. At this time, the system will reboot to prepare for the operating system installation. When prompted, insert the Windows NT Server 4.0/Enterprise Edition (Retail) or Windows NT Server 4.0/Enterprise Edition (Select) CD.
10. When prompted, install Service Pack 3. After Service Pack 3 is installed, the server reboots and Enterprise Edition Installer loads automatically.
11. Exit the Enterprise Edition Installer.

IMPORTANT: Node2 Exception: Open Disk Administrator and when prompted for drive signature stamp, choose yes. After this process is complete, exit Disk Administrator.

---

12. Open Disk Administrator and create disk partitions.
13. Power down the server, insert Options ROMPaq diskette in Node1, and restart the system.

IMPORTANT: When updating the firmware on the array controllers, make sure that Node2 is powered off.

IMPORTANT: Node2 Exception: Do not update the firmware on the array controllers when setting up Node 2. Skip to step 17.

---

14. Run Options ROMPaq from diskettes and choose to update the firmware on the array controllers.
15. After firmware update completes, power down the storage and server.

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16. Power on storage and wait for drives to spin, then power on the server.
17. If setting up an HA/F200, install Redundancy Manager.

    To automatically install Redundancy Manager Redundancy Manager:

    a. Place the Compaq Redundancy Manager (Fibre Channel) CD in the CD-ROM drive. It automatically loads the Install program.
    b. Follow the instructions offered by the Redundancy Manager installation screens.
    c. Remove the Compaq Redundancy Manager (Fibre Channel) CD from the CD-ROM drive.
    d. Reboot the server.

    Redundancy Manager is now installed on your computer. To use Redundancy Manager, double-click the icon.

    To manually install Redundancy Manager:

    a. Place the Compaq Redundancy Manager (Fibre Channel) CD into the CD-ROM drive.
    b. Select **Settings** from the Start menu.
    c. Select **Control Panel** from the Settings menu.
    d. Select **Add/Remove Programs** from the Control Panel.
    e. Click **Install** from the Add/Remove Programs page.
    f. Click **Next** from the Add/Remove Programs page.
    g. Click **Browse** from the Add/Remove Programs page.
    h. Locate the Redundancy Manager *SETUP.EXE* file on the Compaq Redundancy Manager (Fibre Channel) CD.
    i. Click **Finish** from the Add/Remove Programs page. The setup program begins.
    j. Follow the instructions displayed on the Redundancy Manager installation screens.
    k. Close the Control Panel.
    l. Remove the Compaq Redundancy Manager (Fibre Channel) CD from the CD-ROM drive.
    m. Reboot the server.

    Redundancy Manager is now installed on your computer. To use Redundancy Manager, double-click the icon.

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IMPORTANT: Node2 Exception: Repeat SmartStart Assisted Integration steps 1-11 for Node2. Then proceed to step 17.

IMPORTANT: Node1 Exception: Execute step 18 only after Node2 is set up.

18. Run the Compaq Cluster Verification Utility (CCVU) on both nodes to ensure that your system is ready for cluster installation.

    Use the Compaq Cluster Verification Utility CD in your cluster kit to install the Compaq Cluster Verification Utility, then follow the steps listed below.

    To automatically install CCVU, insert the Compaq Cluster Verification Utility CD in the CD-ROM drive. Installation should automatically run.

    If manual installation is necessary:

    a. Select **Start**, **Run**.

    b. Click **Browse** and select the CD-ROM drive.

    c. Double-click *SETUP.EXE*.

    Follow these steps to run the Compaq Cluster Verification Utility:

    a. On the Microsoft Windows NT desktop, select **Start**, **Programs**, **Compaq Utilities**, **Compaq Cluster Verification Utility**.

    b. Select a **Test** by highlighting the cluster model you are verifying.

    c. Click **Next**.

    d. Select one or two computers on which to perform the verification tests.

    e. Click **Add** to add a computer to the selected list.

    f. Click **Finish**. You must have at least one computer on the selected list before clicking **Finish**.

    NOTE: You must have administrative accounts with identical username and password on the computers selected.

    g. Click **Remove** to remove a computer from the selected list.

    For more information about CCVU, refer to the online documentation (CCVU.HLP) included on the CD.

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19. Open the Enterprise Edition Installer and install MSCS on both cluster nodes as outlined in MSCS documentation.
20. Run CCVU again to verify successful cluster installation.
21. After cluster installation completes, install Windows NT Service Pack 5. For the latest information on Service Packs, please refer to the release notes.
22. Run the Compaq Support Software Disk (SSD) through the diskettes you created or from the SmartStart CD and verify that all installed drivers are current.
23. Install your applications and managing and monitoring software. Refer to the Compaq Insight Manager Installation Poster for information on installing Compaq Insight Manager on the management console and Insight Management Agents on servers and desktops. Compaq Intelligent Cluster Administrator CD is located in your HA/F200 cluster kit and is available as an orderable option for the HA/F100. Installation steps for installing Compaq Intelligent Cluster Administrator can be found later in this chapter and in the *Compaq Intelligent Cluster Administrator Quick Setup Guide*.

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Manual Installation Using SmartStart

To perform a manual installation perform the following steps:

IMPORTANT: Power off Node2 when setting up Node1

1. Power up the shared storage. Place the SmartStart CD in the CD-ROM drive of the cluster node.
2. Follow the steps on the SmartStart Setup Poster, making sure you select **Manual Configuration** as the SmartStart installation path.
3. Select **Microsoft Windows NT Server 4.0/Enterprise Edition (Retail)** or **Microsoft Windows NT Server 4.0/Enterprise Edition (Select)** as the operating system. The edition of Windows NT that you select will be determined by the version of the software you have.
4. After this process is complete, restart the computer.
5. When you restart the computer, SmartStart will automatically create your system partition.

IMPORTANT: Node2 Exception: When configuring Node2, the Array Configuration Utility shows the results of the shared drives configured during Node1 setup. Accept these changes for Node2 by exiting.

NOTE: Create a logical drive with 100MB of space to be used as the quorum disk.

6. Next, SmartStart will automatically run the Array Configuration Utility. Refer to the *Compaq StorageWorks RAID Array 4000 User Guide* for instructions about creating RAID sets.

IMPORTANT: Node2 Exception: When configuring Node2, exit out of the Diskette Builder Utility, remove SmartStart CD and go to step 12.

7. After you have completed using the Array Configuration Utility, the system will reboot and present a menu screen. Choose to run Create Support Software. This will load the Diskette Builder Utility. After the Diskette Builder Utility has loaded, create the Options ROMPaq utility, and Compaq Software Support Disk (SSD). Label the diskettes you create. The Options ROMPaq utility updates the firmware on the array controllers and the hard drives. For more information about Options ROMPaq, refer to the *Compaq StorageWorks RAID Array 4000 User Guide*.
8. Exit and remove the SmartStart CD.

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9. Power down the server, insert Options ROMPaq diskette in Node1, and restart the system.

IMPORTANT: When updating the firmware on the array controllers, make sure that one server is powered off.

IMPORTANT: Node2 Exception: Do not update the firmware on the array controllers when setting up Node 2. Skip to step 12.

10. Run Options ROMPaq and choose to update the firmware on the array controllers.
11. After firmware update completes, power down the storage and server. Power on storage and wait for drives to spin, then power on the server.
12. Insert the Microsoft Windows NT Server 4.0/Enterprise Edition (Retail) or Microsoft Windows NT Server 4.0/Enterprise Edition (Select) CD.
13. When prompted, install Service Pack 3. After Service Pack 3 is installed, the server reboots and Enterprise Edition Installer loads automatically.
14. Exit the Enterprise Edition Installer.
15. Run the Compaq Support Software Disk using the diskettes you created in Step 7 or insert the SmartStart CD and run the SSD directly from there. Install all necessary drivers and utilities. Refer to the Support Software Disk online help for more details. Reboot when prompted.

IMPORTANT: Node2 Exception: Open Disk Administrator and when prompted for drive signature stamp, choose yes. After this process is complete, exit Disk Administrator.

16. Open Disk Administrator and create disk partitions.
17. If setting up a Compaq ProLiant HA/F200, install Redundancy Manager, which is described in step 17 of the SmartStart Assisted Integration steps, then continue with the next step.

IMPORTANT: Node1 Exception: Execute step 18 only after Node2 is set up.

18. Run the Compaq Cluster Verification Utility (CCVU), which is described in step 18 of the SmartStart Assisted Integration steps, then continue with the next step.

IMPORTANT: Node2 Exception: Repeat SmartStart Assisted Integration steps 1 through 17 for Node2. Then proceed to step 19.

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19. Open the Enterprise Edition Installer and install MSCS on both cluster nodes as outlined in MSCS documentation.
20. Run the CCVU to verify a successful cluster installation.
21. After cluster installation completes, install Windows NT Service Pack 5. See the latest release notes for the latest service pack information.
22. Run Compaq Support Software Diskette (SSD) through the diskettes you created or from the SmartStart CD and verify that all installed drivers are current.
23. Install your applications and managing and monitoring software. Refer to the Compaq Insight Manager Installation Poster for information on installing Compaq Insight Manager on the management console and Insight Management Agents on servers and desktops. Compaq Intelligent Cluster Administrator CD is located in your HA/F200 cluster kit and is available as an orderable option for the HA/F100. Installation steps for installing Compaq Intelligent Cluster Administrator can be found later in this chapter and in the *Compaq Intelligent Cluster Administrator Quick Setup Guide*.

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Compaq Intelligent Cluster Administrator

Compaq Intelligent Cluster Administrator (CICA) supports a variety of preconfigured cluster options. These options can be initialized on your cluster if you have the appropriate software installed. After you have installed Compaq Intelligent Cluster Administrator you can select from a menu of preconfigured cluster configurations, and they will automatically be applied to your cluster.

The *Compaq Intelligent Cluster Administrator Setup Guide* and CD are located in your HA/F200 cluster kit. If you are setting up an HA/F100 configuration, you can order Compaq Intelligent Cluster Administrator separately.

Installing Compaq Intelligent Cluster Administrator

To install Compaq Intelligent Cluster Administrator on your system:

1. Insert the Intelligent Cluster Administrator CD.
2. Click the Explore button.
3. Double-click the CICA folder.
4. Double-click *SETUP.EXE*.
5. The Compaq Intelligent Cluster Administrator will begin installation. If a previous version of the product is installed, the service will be stopped and the new version will be installed.
6. Double-click on the Setup icon on the installation disk and follow the instructions. The program will be deployed into the C:\COMPAQ\CICA directory. If this directory does not exist, the installation program will create it. Once installed, the files should not be moved.
7. Set the effective User ID for the Compaq Intelligent Cluster Administrator service to the Windows NT domain administrator user account.
8. Repeat these steps to install the software on the other cluster node.

For more specific instructions about using Compaq Intelligent Cluster Administrator, refer to the *Compaq Intelligent Cluster Administrator Quick Setup Guide*, which is included in your HA/F200 cluster kit.

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Compaq has worked directly with several application vendors throughout the development of Compaq ProLiant clusters. As a result of these efforts, Compaq provides a number of Integration TechNotes and White Papers to assist you with installing these applications in a Compaq ProLiant Cluster environment.

Visit to the Compaq High Availability website (http://www.compaq.com/highavailability) to download the most current Integration TechNotes and other technical documents.

Additional Cluster Verification Steps

The following information describes several Microsoft Cluster Administrator steps for verifying the creation of the cluster, verifying node failover, and verifying network client failover.

Verifying the Creation of the Cluster

After you have installed the software and placed the servers in a fresh state, verify creation of the cluster using the following steps.

1. Shut down and power off both servers.
2. Power off and then power on the RA4000.
3. Power both servers back on.

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When Windows NTS/E finishes booting up on both servers, follow these steps to use Microsoft Cluster Administrator to verify creation of the cluster:

1. From the Windows NTS/E desktop on either cluster server, select Start, Programs, Administrative Tools (Common), Cluster Administrator.
2. When you are prompted for Cluster or Server Name, enter the name or IP address of one of the cluster nodes.

   If the cluster has been created correctly, the computer names of both cluster nodes appear on the left side of the Cluster Administrator window (see Figure 3-2).

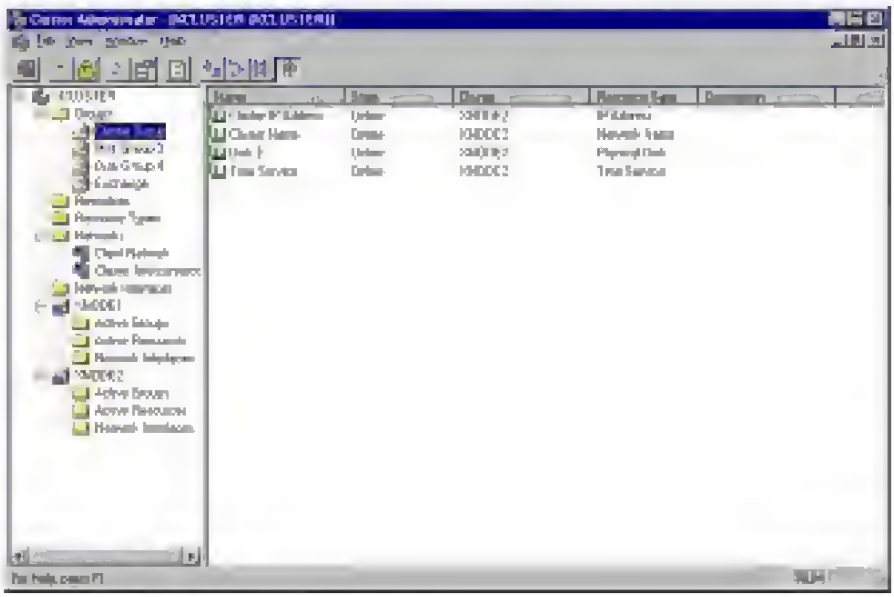

Figure 3-2. Microsoft Cluster Administrator

3. If the cluster is not working correctly, see the installation troubleshooting tips in Chapter 6.

Verifying Node Failover

NOTE: Do not run any client activity while testing failover events.

Follow these steps to verify failover of a cluster node:

1. From the Windows NTS/E desktop on both servers, select Start, Programs, Administrative Tools (Common), Cluster Administrator.
2. When you are prompted for Cluster or Server Name, enter the name or IP address of one of the cluster nodes

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3. Make sure all predefined resources and groups are online. Verify that some of the resources and groups are owned by the server you will be powering off, so that a failure event will result in failover of resources and/or groups.
4. Power off one of the cluster nodes.

   Within several seconds, Microsoft Cluster Administrator will bring online all of the predefined resources and groups that were previously owned by the powered-off server. If, after a minute, nothing appears to have happened, refresh the screen by selecting Refresh (**F5**).
5. If failover is not working correctly, see the installation troubleshooting tips in Chapter 6.

Verifying Network Client Failover

After you have verified that each server is correctly running as a cluster node, the next step is to verify that network clients can interact with the cluster.

The following steps will lead you through this validation procedure:

1. Ensure both cluster nodes are running, and verify, by means of Microsoft Cluster Administrator, that all groups and resources are online.
2. For each hard disk in the shared storage, MSCS automatically creates a cluster group that consists of a single resource, the disk drive. Using Microsoft Cluster Administrator, add an existing IP address as another resource to one of these groups. (Do NOT use the Cluster Group.) Save the changes and return to the main Cluster Administrator screen.
3. Open a DOS window on a network client machine.
4. Ensure the network client can access the IP address. Regardless of whether you are using WINS or DHCP, you can execute the DOS command ping to check the connection.

   Execute a Ping command from the network client , using the cluster IP address as the argument.

   The client has successfully accessed the cluster resource if you get a response similar to:

   ```
   Reply from <IP Address>: bytes=xx time=xxxms TTL=xx.
   ```

   The client has not successfully accessed the cluster resource if you get a response of:

   ```
   Reply from <IP Address>: Destination host unreachable
   ```

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5. Use Microsoft Cluster Administrator to perform a manual failover of the cluster group that contains the IP address.
6. After the manual failover completes, execute the ping command again.
7. As soon as the other node brings the cluster group online, a response similar to the one noted in Step 4 should be returned. If the client successfully accessed the failed-over IP address, your cluster is working. If the client was unsuccessful, either the cluster group was not configured correctly, the failover did not occur, or the ping command was performed before the failover activity completed.
8. If network client failover is not working correctly, see the installation troubleshooting tips in Chapter 6.

To verify a more extreme case, instead of failing over the IP address, power off the primary cluster node and verify that the resource fails over to the other node.

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Chapter 4

Upgrading the HA/F100 to an HA/F200

Preinstallation Overview

The difference between the Compaq ProLiant Cluster HA/F100 and the HA/F200 is the addition of a dual redundant loop. This redundant loop provides the HA/F200 cluster with no single points of failure in the connection between the servers and the storage subsytem(s).

Adding this loop to an existing HA/F100 configuration requires the following:

- One additional Compaq StorageWorks RA4000 Controller (array controller) per storage subsystem
- One additional Compaq StorageWorks Fibre Channel Storage Hub
- One additional Compaq StorageWorks Fibre Channel Host Adapter (host bus adapter) per server
- Compaq Redundancy Manager (Fibre Channel) software
- Appropriate firmware and drivers

If you already have a Compaq ProLiant Cluster HA/F100 up and running, you do not need to repeat the installation of those hardware components described in Chapter 3. However, the upgrade from the HA/F100 to the HA/F200 will require the addition of the dual redundant loop hardware components, the Redundancy Manager software and updated Windows NT device drivers and firmware. These additional steps are described in Chapter 4.

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Materials Required

You need the following during installation:

- Hardware components and related documentation for installing the redundant loop
  - One additional Compaq StorageWorks RA4000 Controller (array controller) per storage subsystem
  - One additional Compaq StorageWorks Fibre Channel Storage Hub
  - One additional Compaq StorageWorks Fibre Channel Host Adapter (host bus adapter) per server
- Compaq SmartStart for Servers CD
- Compaq SmartStart for Servers Setup Poster
- Server Profile Diskette (included with SmartStart)
- Microsoft Windows NT Server 4.0/Enterprise Edition software and documentation
- Compaq Redundancy Manager (Fibre Channel) software
- Monitoring and management software (optional)
  - Compaq Insight Manager software and documentation
  - Compaq Insight Manager XE software and documentation
  - Compaq Intelligent Cluster Administrator software and documentation
- At least ten high-density diskettes
- Windows NT Server 4.0 Service Packs

IMPORTANT: Refer to Appendix C to determine which Service Packs and software and firmware version levels your cluster requires.

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Upgrade Procedures

IMPORTANT: The instructions in this chapter apply if you are upgrading an existing HA/F100 configuration. To begin a new installation of an HA/F100 or HA/F200, begin with Chapter 3.

Before beginning these upgrade procedures, you should have a Compaq ProLiant Cluster HA/F100 up and running. To complete the installation of your HA/F200, follow these steps:

1. Insert the SmartStart CD into the CD-ROM drive while the cluster is online in Node1.
2. Create Options ROMPaq from the Diskette Builder utility. Label the diskettes.

IMPORTANT: Run Options ROMPaq even if you choose not to use SmartStart. Instead of creating Options ROMPaq from Diskette Builder, you can download Options ROMPaq from the Compaq High Availability website (http://www.compaq.com/highavailability).

3. Create Support Software Disk (SSD) from the Diskette Builder utility. Run the Support Software Disk (SSD) either from the diskettes or directly from the SmartStart CD. Install the latest Fibre Channel drivers and other server components. **Do not reboot** when prompted to do so.
4. Run the SSD on Node2 and install the latest Fibre Channel drivers and other server components, with the disks you created in step 3 or directly from the SmartStart CD. **Do not reboot** when prompted to do so.
5. Install Redundancy Manager on both nodes. Information about installing Redundancy Manager is detailed in step 17 of the Chapter 3 Assisted Integration steps.
6. Power down both servers and storage when Redundancy Manager prompts for restart.
7. Install additional hardware:
   a. Add another host bus adapter in each node.
   b. Add another array controller in each RA4000.
   c. Cable the additional host bus adapters and array controller(s) to the additional storage hub.

IMPORTANT: To ensure that your HA/F200 fails over properly, attach each host bus adapter in a single server to a different hub, and attach each array controller in the RA4000 to a different hub. See the hardware installation procedures in Chapter 3.

8. Power on the storage and Node1.

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9. lnsert the first Options ROMPaq diskette that you created in Diskette Builder. Run Options ROMPaq and choose to update the firmware on the array controllers.
10. Power down the storage and Node1 after the firmware update completes.
11. Power on the storage, wait for drives to spin, then power on both nodes.
12. Run the Compaq Cluster Verification Utility. Instructions for installing and running CCVU are in step 18 of the Chapter 3 Assisted lntegration steps.
13. Run Redundancy Manager to verify that redundant paths are operational. Instructions for running Redundancy Manager are described in step 17 of the Chapter 3 Assisted Integration steps.
14. lnstall Windows NT Service Pack 5. For latest information on service packs, refer to the HA/F200 release notes.
15. Run the Software Support Disk (SSD) through the diskettes you created or from the SmartStart CD, and verify that all installed drivers are current.
16. lnstall your applications and managing and monitoring software.
    a. Refer to the Compaq Insight Manager Installation Poster for information about installing Compaq Insight Manager on the management console and Insight Management Agents on servers and desktops.
    b. Compaq Intelligent Cluster Administrator CD is located in your HA/F200 cluster kit. Installation steps for installing Compaq Intelligent Cluster Administrator can be found in Chapter 3 and in the *Compaq Intelligent Cluster Administrator Quick Setup Guide*.

For information about verifying the creation of the cluster, verifying node failover, and verifying network client failover using Microsoft Cluster Administrator, see the "Additional Cluster Verification Steps" section in Chapter 3.

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Chapter 5

Managing the Compaq ProLiant Clusters HA/F100 and HA/F200

Throughout the life of a cluster, there will be the need to improve the performance, upgrade hardware components, upgrade software, increase storage capacity, restructure cluster groups, backup cluster data, and monitor ongoing activities. This chapter describes these management concepts as they pertain to clusters. The chapter also details the utilities and programs used in the ongoing management of Compaq ProLiant Clusters HA/F100 and HA/F200. The topics addressed in this chapter include:

- Managing a Cluster Without Interrupting Cluster Services
- Managing a Cluster in a Degraded Condition
- Managing Hardware Components of Individual Cluster Nodes
- Managing Network Clients Connected to a Cluster
- Managing a Cluster's Shared Storage
- Remotely Managing a Cluster
- Viewing Cluster Events
- Modifying Physical Cluster Resources
- Backing up your Cluster
- Managing Cluster Performance

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The chapter also details the utilities and programs used in the ongoing management of Compaq ProLiant Clusters HA/F100 and HA/F200. The tools addressed in this chapter include:

- Compaq Redundancy Manager (Fibre Channel)
- Compaq Insight Manager
- Compaq Insight Manager XE
- Compaq Intelligent Cluster Administrator
- Microsoft Cluster Administrator

Managing a Cluster Without Interrupting Cluster Services

At some time during the life of a cluster, it is likely that a cluster node will have to be powered off in order for the administrator to perform an operation. Always use Cluster Administrator to fail over (or at a minimum to bring offline) clustered applications before powering off the server.

Managing a Cluster in a Degraded Condition

Due to the highly available nature of clustering, applications and network clients remain operational even while some cluster components do not. When the cluster is in this degraded condition, follow this process:

1. Understand what caused the degradation. Use Compaq Insight Manager or Compaq Insight Manager XE to determine the problem.
2. Determine whether the condition will continue to worsen.
3. Determine how critical the problem is.
   a. If the problem is considered noncritical, wait until a nonpeak time to service the problem. (Using Intelligent Cluster Administrator, you can usually work around the problem and continue successful cluster operations.)
   b. If the problem is considered critical, fail over all clustered applications and resources to the other server before servicing the problem. (This can be accomplished using Intelligent Cluster Administrator through a browser or using the Insight Manager console when linked with MSCS Cluadmin.)

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Managing Hardware Components of Individual Cluster Nodes

Compaq Insight Manager has been enhanced to operate with the Compaq ProLiant Clusters HA/F100 and HA/F200. Compaq Insight Manager XE allows you to view and manage servers and their components, and it now allows you to view two cluster nodes as a single cluster entity. A comprehensive overview of the cluster capabilities of Compaq Insight Manager is presented later in this chapter.

Compaq Insight Manager XE is a product for systems administration and management. Compaq Insight Manager XE, with the Cluster Monitor component, is a Web-based subsystem that monitors the operation of Compaq servers and storage devices configured as Microsoft NT clusters. Cluster Monitor has been designed to improve Microsoft Cluster Server (MSCS) cluster administration and control, and it relies heavily on the Compaq Insight Manager Web-enabled agents (as well as other agents) for basic information about system health. A full description of the Compaq Insight Manager XE capabilities is included later in this chapter.

Managing Network Clients Connected to a Cluster

An important aspect of managing network clients is to inform the users that their applications are now running on a cluster. Since users will experience some disruption of service and, possibly, a performance degradation during failover, they might become concerned about the availability and stability of their applications. As the cluster is initially brought into a production environment, explain the effects a cluster will have on the users' information systems needs.

When a failover or failback event occurs, the users may be unable to access their application and/or data for a brief period. Users who have been properly forewarned of the effects of operating in a clustered environment will more readily recognize when a failover or failback event is occurring or has occurred.

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Managing a Cluster's Shared Storage

Compaq Insight Manager and Compaq Insight Manager XE monitors the RAID Array 4000 storage system from both a physical and a logical perspective:

- The physical drives and Fibre Channel hardware are monitored through the Mass Storage Overview screen, accessed from the Device View screen.
- The shared logical drives (as well as other cluster resources and services) are monitored by the Cluster Management and Cluster Shared Resources screens, accessed from a cluster folder in the Device List.

Because this storage system is shared, either cluster node could be the owner of any shared logical drive. While only one node can own the logical drive at any given time, ownership can switch from one node to another. Cluster support of Compaq Insight Manager reports the current owner of a logical drive and updates this information dynamically if a failover occurs.

NOTE: The Compaq Insight Manager tools show the shared logical drives as cluster resources owned by a particular node. They show the Fibre Channel hardware as a physical resource of both servers in the cluster.

When viewing the Compaq Insight Manager Cluster Shared Resources screen, you can determine which RA4000 contains a particular drive by looking at the Physical ID field under the Shared Resources heading.

Remotely Managing a Cluster

The Compaq Insight Manager tools, Compaq Insight Manager XE, Compaq Intelligent Cluster Administrator, and Microsoft Cluster Administrator can run from network client machines. Each program allows you to monitor multiple clusters from a single remote client. In addition, Compaq Insight Manager XE and Compaq Intelligent Cluster Administrator can be run from a Web browser providing even greater flexibility than console-based or client attached devices. See the corresponding documentation to determine how to set up and configure each of these programs to run remotely.

Viewing Cluster Events

Cluster events are logged in the Windows NT Event Log. Use the Windows NT Event Viewer to view the data in the Event Log.

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Modifying Physical Cluster Resources

Removing Shared Storage System

Each cluster node, and the cluster as a whole, depends on the shared storage for data, log, and, possibly, application program files. If the shared storage is removed, all clustered applications that are dependent on that shared storage system will be offline. Clearly, network clients will not have access to the clustered applications.

NOTE: These procedures for removing a shared storage system assume that you are making modifications to a previously configured HA/F100 or HA/F200.

To remove a shared storage from your cluster, follow the steps below:

1. Use Cluster Administrator to bring offline all cluster groups and cluster resources including physical disk resources dependent on the RA4000 you are about to remove from the cluster.
2. Power off the RA4000 you are about to remove. Remove the Gigabit Interface Converter (GBIC) and the cable from the storage hub.
3. Delete the cluster groups and resources you brought offline in step 1.

Adding Shared Storage System

A Compaq StorageWorks RAID Array 4000 cannot be dynamically added to the cluster. Follow these steps to add another shared storage system to an existing cluster.

NOTE: These procedures for adding a shared storage system assume that you are making modifications to a previously configured HA/F100 or HA/F200.

The following method of adding shared storage assumes:

- Service Pack 5 for Windows NT 4.0 is applied.
- Compaq SmartStart CD 4.10 or later is used to apply system drivers.

1. Power down one of the cluster servers (Node2).
2. Insert the Compaq SmartStart and Support Software CD into the CD-ROM drive of the other cluster server (Node1). Power down Node1.
3. Insert all of the SCSI drives into the RA4000.

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IMPORTANT: If using a Compaq ProLiant Cluster HA/F200 with redundant paths, be sure to attach both array controllers, one to each hub.

4. Add the additional RA4000 to the storage subsystem. Follow the hardware installation steps detailed in Chapter 3 of this guide.
5. Power on the newly added RA4000.
6. Power on Node1 and run the Array Configuration Utility (ACU). Create a new drive. Refer to the *Compaq StorageWorks RAID Array 4000 User Guide* for more information about Compaq Array Configuration Utility.

IMPORTANT: Be sure to understand your cluster groupings for applications and resources whose data, log, and, possibly, program files will reside on these drives. See Chapter 2 for information about creating cluster groups.

7. Save the configuration changes and exit ACU. Remove the SmartStart CD.
8. Boot Windows NT on Node1, then run Disk Administrator to assign permanent letters to the drive volumes and configure newly added disk for use in a cluster. Refer to MSCS and Windows NT documentation for more details.
9. Open Cluster Administrator. The newly created disk is now ready to participate in the cluster. Follow MSCS documentation for details about adding new cluster resources.

IMPORTANT: Do not run the Array Configuration Utility on the second cluster node. The information entered from the first cluster node is maintained on the drives; therefore, the drives are already configured for the second node.

10. Power on Node2 and log onto Windows NT. Refer to MSCS documentation for procedures to verify that the newly created cluster resources are operational on Node2.

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Adding or Removing Shared Storage Drives

There are two situations in which you might add or remove drives from the shared storage:

NOTE: These procedures for adding or removing shared storage drives assume that you are making modifications to a previously configured HA/F100 or HA/F200

- When one of the drives fails. In this case, you are simply exchanging the failed drive for a new one.
- When you want to add capacity to your RA4000.

In both situations, it is assumed you are employing RAID 1, 4, or 5 for all of the devices in the storage unit.

CAUTION: To add or remove drives from the RA4000, you must follow certain rules that are interpreted by reading the LEDs on the RA4000. Read the *Compaq StorageWorks RAID Array User Guide* to understand these rules. Failure to follow these rules may result in loss of data.

Replacing a Failed Drive

The procedure for replacing a failed drive is completed within the RA4000 storage system. Neither MSCS nor Windows NT is aware of the change, and operation of both continues without interruption.

IMPORTANT: If the failed drive was not configured to use RAID 1, 4, or 5 (that is, your drives have no fault tolerance), you may lose some or all of the data on the failed drive.

Refer to the *Compaq StorageWorks RAID Array 4000 User Guide* for instructions on replacing a failed drive.

Adding Drives to Increase Storage Capacity

The following steps describe how to add a drive to the Compaq RA4000 storage system and to allocate it to MSCS.

NOTE: These procedures for adding drives to increase storage capacity assume that you are making modifications to a previously configured HA/F100 or HA/F200

The following method of adding shared storage assumes:

- Service Pack 5 for Windows NT 4.0 is applied.
- Compaq SmartStart CD 4.10 or later is used to apply system drivers.

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1. Power down one of the cluster servers (Node2).
2. Insert the Compaq SmartStart and Support Software CD the other cluster server (Node1). Power down Node1.
3. Insert new drives in the RA4000 storage array.

IMPORTANT: If using a Compaq ProLiant Cluster HA/F200 with redundant paths, be sure to attach both array controllers, one to each hub.

4. Power on the Node1 and run the Array Configuration Utility (ACU). Refer to *Compaq StorageWorks RAID Array 4000 User Guide* for more information about creating a new logical drive from free space on an existing array, an expanded array, or a new array.

IMPORTANT: Be sure to understand your cluster groupings for applications and resources whose data, log, and, possibly, program files will reside on these drives. See Chapter 2 for information about creating cluster groups.

5. Save the configuration changes and exit ACU. Remove SmartStart CD.
6. Boot Windows NT on Node1, then run Disk Administrator to assign permanent letters to the drive volumes and configure newly added disk for use in a cluster. Refer to MSCS and Windows NT documentation for more details.
7. Open Cluster Administrator. The newly created disk is now ready to participate in the cluster. Follow MSCS documentation for details about adding new cluster resources.

IMPORTANT: Do not run the Array Configuration Utility on the second cluster node. The information entered from the first cluster node is maintained on the drives; therefore, the drives are already configured for the second node.

8. Power on Node2 and log onto Windows NT. Refer to MSCS documentation for procedures to verify that the newly created cluster resources are operational on Node2.

NOTE: You cannot increase the capacity of an existing Windows NT drive volume, but you can assign a new drive letter to the extra capacity furnished by the added drives.

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Physically Replacing a Cluster Node

To simplify integration of the new cluster node, retain the Windows NT boot drives from the node being replaced for use in the replacement node. If this is not possible, perform the steps described in the Chapter 3 Assisted Integration procedure for adding a second node.

NOTE: These procedures for physically replacing a cluster node assume that you are making modifications to a previously configured HA/F100 or HA/F200.

Replacing a Cluster Node

To replace an existing cluster node:

1. Ensure all cluster groups are running on the remaining cluster node (Node1, for example). Fail over to the remaining node any cluster groups that are running on the node being replaced (Node2).
2. Open Cluster Administrator on Node1. Right click Node2. Select Evict Node to remove Node2 from the cluster.
3. Once Node2 is removed from the cluster, shut it down and power it off.
4. Remove the interconnect, LAN, Fibre Channel cables, and power cables. Remove any other cables that are attached to the node. If the node is in a rack, remove it from the rack.
5. Remove all hardware devices that will be used in the new node from the node being replaced and place them in the new node. Install all other hardware devices into the new node.
6. If the new node is part of a rack system, place the server in the rack. Attach the interconnect, LAN, Fibre Channel cables, and power cables.

If you are using the Windows NT boot drives from the replaced node in the new node, power on the new node and follow the steps described in "Verifying Integration of the Replacement Node." Add or replace device drivers for any components that have been added or removed.

If you are recreating the new node, follow installations steps as outlined in Chapter 3.

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Installing a New Windows NT Boot Drive

New Windows NT boot drives require installation of Windows NT, configuration of the networking components of the new node, and installation of MSCS. Follow the SmartStart Assisted Path installation steps for Node2 as outlined in Chapter 3.

NOTE: When installing MSCS, be sure to join the existing cluster.

Backing Up Your Cluster

The need for cluster backup is essential for both business-critical and nonbusiness-critical data. As data becomes an increasingly valued company asset, it needs to be backed up on a regular basis. The process of backing up data will ensure that a company's assets are secure and available when a disaster strikes. The cluster itself provides a high degree of application availability but does not prevent a user from deleting or corrupting a file or set of files. Backing up a cluster's data will increase the overall level of data availability.

There are several methods for backing up clustered systems, including:

- Both cluster nodes attached to a single tape backup device, such as the Fibre Channel-based Compaq StorageWorks Enterprise Backup Solution.
- Two-tape backup subsystems where one tape backup subsystem is attached to each cluster node.
- A separate backup server that uses the standard public client LAN as the backup path.

Tape backup software varies in its level of cluster-aware integration and operation. Contact your tape backup software vendor for more details regarding their specific cluster implementation and support.

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Managing Cluster Performance

As applications or resources transfer from one server to another, the performance of the clustered servers will likely change. The extent of the change depends on how well equipped the other node is to handle the increased workload. This is especially obvious after a server failure, where all of the cluster resources may move to the other server.

Use the Windows NT Performance Monitor to observe and track system performance. Some applications have their own internal performance measurement capabilities. Constant monitoring of each system's performance in a cluster may identify a disparity in the workload being performed by each server. Adjust the distribution of the cluster applications so that the overall cluster performance is maximized.

Dynamic load balancing is not available in the initial release of MSCS. However, MSCS can manually load balance your cluster nodes. Information obtained from Performance Monitor can be used to determine whether either of the cluster nodes is operating at too high a performance level. Then use Cluster Administrator to fail over as many cluster groups as necessary to balance the load of each cluster node. Additionally, disk I/O may be balanced across the dual host bus adapters in a Compaq ProLiant Cluster HA/F200 configuration. This functionality is only available when accessing two separate RAID arrays.

The timing of manual load balancing depends on the type of group to be moved and how many clients are using the group. File and print services are normally not business-critical, nor do they sustain an extremely high utilization rate. For these reasons, file and print services are good candidates to move whenever load balancing needs to occur, even when the overall cluster utilization is high.

However, some applications, such as databases, should not be moved from one server to another during peak processing periods. To move a database from one server to another, the database must be shut down and restarted. Users do not have access to the database during the time it takes the database to restart. Move a database group to another server during nonpeak hours.

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Compaq Redundancy Manager

Compaq Redundancy Manager (Fibre Channel) increases the availability of single-server or clustered systems using Compaq StorageWorks RAID Array 4000. Redundancy Manager can detect failures of the Compaq StorageWorks Fibre Channel Host Adapter (host bus adapter), Compaq StorageWorks RA4000 Controller (array controller), and Fibre Channel data paths. It then reroutes the I/O processing. Redundancy Manager is a monitoring tool; it is not a real-time management tool.

This section provides information on how to use and configure Redundancy Manager by providing the means to change and set active and standby paths. See Appendix B for information about using Redundancy Manager in a single-server environment.

Figure 5-1 is an example of the Compaq Redundancy Manager (Fibre Channel) main screen.

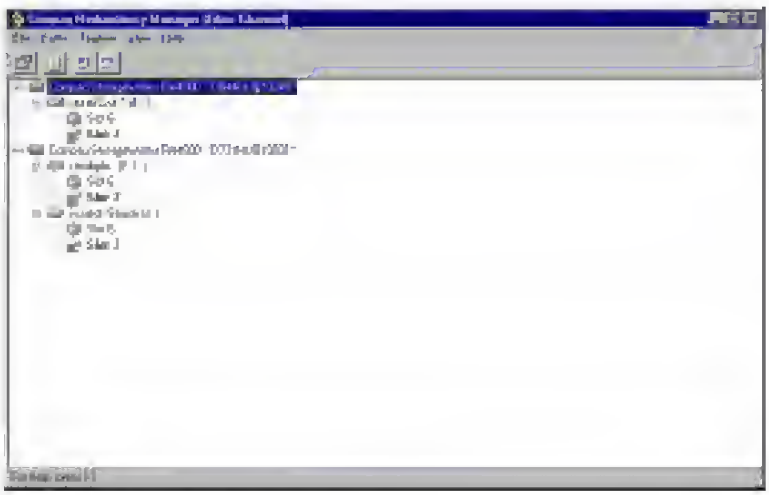

Figure 5-1. Example of the main screen

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Changing Paths

Redundancy Manager allows you to change the active and standby paths for your cluster. The following provide instructions for changing paths.

> **NOTE:** Redundancy Manager will not change the configuration until you close the Redundancy Manager program or select Apply Changes. The main screen may not show the current system configuration. Use Refresh (**F5**) to update the main screen to see the current configuration.

Changing from Standby to Active Paths

To change a path from Standby to Active mode:

1. Highlight the Standby path you want to change.
2. Select Path from the main screen menu bar.
3. Select Set As Active from the Path menu.

The selected Standby path will change to Active when you select Apply Changes or close Redundancy Manager.

Shortcut method

Following is a shortcut method to change a path from Standby to Active:

1. Highlight the Standby path you want to change.
2. Click the right mouse button to display a pop-up menu.
3. Select Set As Active from the menu.

The selected Standby path will change to Active when you select Apply Changes or close Redundancy Manager.

Changing from Active to Standby Paths

To change a path from Active to Standby mode:

1. Highlight the Active path you want to change.
2. Select Path from the main screen menu bar.
3. Select Set As Standby from the Path menu.

The selected Active path will change to Standby when you select Apply Changes or close Redundancy Manager.

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Shortcut method

Following is a shortcut method to change a path from Active to Standby:

1. Highlight the Active path you want to change.
2. Click the right mouse button to display a pop-up menu.
3. Select Set As Standby from the menu.

The selected Active path will change to Standby when you select Apply Changes or close Redundancy Manager.

Other Functions

Two helpful functions for using the Redundancy Manager graphical user interface (GUI) are Refresh and Rescan.

Refresh

Refresh (**F5**) updates information on the GUI screen, checks for path failures and path changes, and displays the current configuration. The GUI will not update automatically. The changes that you have made will not be saved. Use refresh to update the main screen to see the current configuration or to see if a failure has happened in the system. Refresh does not affect any processing or interrupt any of the system's functions.

Rescan

Rescan is used to check for new host bus adapters and array controllers and after adding and removing physical drives. Use rescan after a hot-swap of host bus adapters or array controllers and after adding or removing physical drives.

NOTE: For every hot replace, a rescan should be run on each machine in a cluster.

NOTE: Reboot each server to clear the SCSI port after seven hot replaces.

1. Select Features from the Main screen.
2. Select Rescan from the Features menu.

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Compaq Insight Manager

Compaq Insight Manager is the Compaq console-based application for easily managing network devices. This application delivers intelligent monitoring and alerting as well as visual control of networked systems.

Compaq Insight Manager, as a console-based monitor and management tool, provides sophisticated hardware element management and monitoring for Compaq ProLiant Clusters. It also contains a launch vehicle for MSCS Cluster Administration "Cluadmin." Compaq Insight Manager and Cluadmin provide a console-based service that can be addressed either directly on the ProLiant Cluster or through a LAN-attached console service. From the Compaq Insight Manager and Cluadmin console, the administrator can monitor the ProLiant Cluster and perform cluster administration functions such as starting and stopping an MSCS service, starting or stopping an MSCS node, and starting or stopping the MSCS cluster.

Compaq Insight Manager consists of two components: a Windows-based console application and server- or client-based management data collection agents. Management agents monitor more than 1,000 management parameters. Key subsystems are instrumented to make health, configuration, and performance data available to the agent software. The agents act upon that data by initiating alarms in the event of faults and by providing updated management information, such as network interface or storage subsystem performance statistics. With Compaq Insight Manager, you have real control over your systems, with monitoring and alerting capabilities for the critical systems in your distributed enterprise.

Compaq Insight Manager is designed to be a key component in the systems management environment. The strength of Compaq Insight Manager lies in its ability to give systems administrators real control through its visual interface, comprehensive fault and configuration management, and industry-leading remote management.

Compaq Insight Manager provides access to Compaq Insight Manager alarm, device, and configuration information through the use of industry-standard web browsers.

NOTE: Compaq Insight Manager XE extends the functionality of Compaq Insight Manager and enables cluster monitoring through the Web. It is available in the HA/F200 cluster kit and is an option for the HA/F100. A detailed description of Compaq Insight Manager XE follows the description of Compaq Insight Manager

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Cluster-Specific Features of Compaq Insight Manager

The following is an overview of the cluster-specific features found in Compaq Insight Manager.

NOTE: The term *cluster group* used in this section refers to Compaq Insight Manager, not to Microsoft Cluster Server.

- When Compaq Insight Manager discovers a cluster, a cluster group is automatically created and added to the Group window of Compaq Insight Manager's Explorer Device List screen. The cluster protocol and address are also displayed.
- Compaq Insight Manager includes cluster management capabilities that allow you to:
  - Launch Microsoft Cluster Administrator.
  - Bring up the Insight Manager Cluster Shared Resources screen.
  - View the status of the cluster service running on each node.
  - View the overall status of all cluster resources.
- From the Compaq Insight Manager Cluster Shared Resources screen you can:
  - View address, transport protocol, and physical ID of all cluster interconnects.
  - View the current state of all cluster resources.
  - Sort the interconnect information and resources by multiple criteria.

In Compaq Insight Manager, all displayed interconnect and resource information is polled and updated dynamically, including status and ownership.

For example, assume two drive volumes are defined in your shared storage. The primary owner of the drive volume labeled E: is Node1. The primary owner of the drive volume labeled F: is Node2. When the cluster is in a normal state, Compaq Insight Manager will show E: as being owned by Node1 and F: as being owned by Node2. When a failover event occurs, ownership of the drives changes. Assume Node1 experiences a failure and its resources fail over to Node2. When the failover is complete and Compaq Insight Manager polls the cluster, Node2 will be identified as the owner of both F: and E:.

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Cluster Group Hierarchy

You can manage cluster groups at an appropriate level in the group hierarchy. Cluster groups are always displayed at the All Devices level, but cluster group *shortcuts* can be added to other groups.

Filter Groups

A filter groups dialog box is used to create, edit, or delete groups in the group list hierarchy.

Cluster Address

A cluster address acts as a proxy, communicating with different servers in the cluster depending on the state of the cluster. A Compaq Insight Manager device using a cluster address may switch communication from one physical device to another, which may result in erroneous information being delivered. Consequently, Compaq Insight Manager does not allow management of a device that uses a known cluster address.

Compaq Insight Manager XE

Compaq Insight Manager XE is the strategic direction for Compaq to provide systems management and administration from the Web. Incorporated within Insight Manager XE is Cluster Monitor, a real-time cluster monitoring system for ProLiant Clusters using Microsoft Windows NT Server 4.0/Enterprise Edition and MSCS. The combination of Insight Manager XE and Cluster Monitor provides complete systems and cluster monitoring and management.

Compaq Insight Manager XE extends management beyond a single system to management of multiple systems using a standard Web browser as the user interface. By enabling browser access to both the managed device and the management application, Compaq Insight Manager XE provides management of devices and groups of devices anywhere, anytime. Additionally, Compaq Insight Manager XE provides real-time management access to Web-enhanced devices and proxy management of traditional SNMP and DMI V2 systems.

Compaq management agents provide health status to either Compaq Insight Manager or Compaq Insight Manager XE. The agents translate data supplied by the device drivers into useful information that assists the user in correctly diagnosing the problem. Compaq Insight Manager or Compaq Insight Manager XE then provide extensive information about how to address the problem, shortening the resolution time.

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Compaq Insight Manager XE offers a simple, industry-standard approach to management for all managed devices. This approach provides a common data repository, a consistent user interface, and the ability to correlate events providing intelligent information about the infrastructure at the department or domain level.

Compaq Insight Manager XE provides device status summary of all managed devices. For Compaq systems, this is a summary of the health status of all the subsystems. The Compaq management agents provide real-time access to the details found in the subsystem health status information.

Compaq Insight Manager XE offers secure access to the management application and Web-enhanced management agents. Such access enhances the security provided by traditional SNMP agents. The management application and management agents authorize the user to look at information, change information and execute operations.

Compaq Insight Manager XE generates subsystem and component views through direct access to networked devices through a standard Web browser, offering administrators a quick and convenient way to diagnose system status.

Compaq Insight Manager XE helps you focus on your computing environment from the perspective of MSCS clusters and their attributes. The following section provides more detailed information about Cluster Monitor.

Cluster Monitor

Cluster Monitor is a Web-based monitor subsystem to Compaq Insight Manager XE. With Cluster Monitor, you can view all clusters from a single browser and configure monitor points and specific operational performance thresholds that will alert you when these thresholds have been met or exceeded on your application systems. Cluster Monitor relies heavily on the Compaq Insight Manager Web-enabled agents for basic information about system health. It also has custom agents that monitor and manage cluster health. Cluster Monitor provides access to the Compaq Insight Manager alarm, device, and configuration information.

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Cluster Monitor has three distinct informational areas to meet individual operational needs:

- A problem window with a prioritized cluster event list sorted by severity for the clusters that are under the administrator's control
- A topology tree displaying all clusters and their respective monitor points, including MSCS health, processor, bus, disk, or network usage and performance thresholds
- A detailed problem definition based on monitored conditions and a proposed resolution to the problem, if one can be determined, with drill down ability to the specific device or system causing a negative or unstable cluster state and the ability to perform corrective actions

The Cluster Monitor reflects the following management information:

- Ownership
- Identified cluster resources
- System hardware and software configuration
- Emergency contacts in the event of cluster state changes
- Application software installed

Use Cluster Monitor to:

- Stay informed through cluster alert notifications of changes in cluster status.
- Monitor cluster status by viewing a list of cluster alerts.
- Investigate the sources of specific alerts.
- Browse cluster and component status in a tree hierarchy.
- Display utilization or status data for specific cluster attributes.
- Create Compaq Insight Manager XE notifications to escalate or document cluster problems.

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Cluster Monitor supports these attributes:

- Disk space
- CPU utilization
- MSCS cluster status
- Node Environment (Compaq Management Agent) status.

  Cluster Monitor uses pop-up notifications, alerts in the alert list, colored icons in a tree hierarchy, and attribute-specific data displays to reveal the state of clusters, their nodes, and attributes.

Refer to the Compaq Insight Manager XE documentation for specific information about how to use Compaq Insight Manager XE and Cluster Monitor.

Compaq Intelligent Cluster Administrator

Compaq Intelligent Cluster Administrator is a Web-based cluster administration agent that runs on Compaq servers. This product is included in the HA/F200 kit. Compaq Intelligent Cluster Administrator is also available with other Compaq ProLiant Cluster offerings and is a stand-alone product as well. The Compaq Intelligent Cluster Administrator Web browser interface enables remote cluster management. With Compaq Intelligent Cluster Administrator, you can reallocate cluster resources to meet processing demands without failing over the cluster. You can also check for any cluster destabilizing conditions, such as disk thresholds or application slowdowns.

Compaq Intelligent Cluster Administrator performs three main functions:

- Monitoring and managing an active cluster
- Managing cluster history
- Importing and exporting cluster configurations

Monitoring and Managing an Active Cluster

Using the monitoring and managing function you can:

- Display and monitor the status of a cluster and all of its objects: nodes, networks, interfaces, and services (resources)
- Modify properties of cluster objects
- Change the state of cluster objects (pause, resume, bring online, take offline)

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- Assign resources to groups and nodes
- Establish resource dependencies
- Assign failover policies for cluster resources
- Fail over resources and nodes
- Stop and start cluster services

Managing Cluster History

Using the Cluster History function, you can:

- Maintain archived configurations in the History list.
- Compare any two archived configurations, or compare an archived configuration with the active cluster configuration.
- Run reports on the active cluster or any archived cluster configurations.

Importing and Exporting Cluster Configurations

Using the Import/Export configuration functionality, you can:

- Import an archived configuration to the active cluster.
- Export a cluster configuration to an archive and save it for later use.
- Restore an archived configuration to the active cluster.

Refer to the *Compaq Intelligent Cluster Administrator Quick Setup Guide* and online documentation for specific information about how to install, configure, and use Intelligent Cluster Administrator.

Visit the Compaq High Availability website (http://www.compaq.com/highavailability) for additional cluster management information.

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Microsoft Cluster Administrator

Microsoft Cluster Administrator manages groups, resources, and the operating state of the cluster. Cluster Administrator gives you the ability to:

- View the current status of cluster groups and resources.
- Bring groups and resources online and offline.
- Manually move groups and resources to another node.
- Manually move groups and resources to their preferred server.
- Pause groups and resources.
- Restructure a group's resource dependency tree.

Cluster Administrator can run remotely or on a cluster node. If Cluster Administrator is installed remotely, the remote node must be in the same domain as the cluster node. When running Cluster Administrator remotely, connect to the cluster by using Compaq Insight Manager or by using the cluster IP address or cluster name.

NOTE: The remote feature is not supported in Microsoft Windows 95.

Refer to the Microsoft documentation for a thorough description of Cluster Administrator features and specifics on how to use the utility.

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Chapter 6

Troubleshooting the Compaq ProLiant Clusters HA/F100 and HA/F200

This chapter addresses problems encountered while installing, configuring, testing, and operating the Compaq ProLiant Clusters HA/F100 and HA/F200. These problems are described in the following troubleshooting categories:

- Installation
- Node-to-Node
- Shared Storage
- Client-to-Cluster Connectivity
- Cluster Groups and Cluster Resources
- Other

In addition, the following Compaq Redundancy Manager (Fibre Channel) event logging, messages, and troubleshooting information is described:

- Informational messages
- Warning messages
- Error messages
- Other

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Installation

This section addresses problems encountered during installation.

Table 6-1
Solving Installation Problems

Problem	Possible Cause	Action
The error message "RPC Server is Unavailable" is displayed.	Name resolution issue.	1. Ensure the server is operational and that the Cluster Service and the RPC services are running. 2. Check the name resolution of the cluster. It is possible that you are using an incorrect name or that the name is not being properly resolved by WINS or DNS.
Cluster Administrator does not appear in the Start menu.	MSCS may not have been successfully installed.	1. Uninstall MSCS (or any pieces that may have installed incorrectly). 2. Reinstall MSCS.
Node Performance is sluggish and the node fails.	Processor may be overloaded.	Verify the processor is not running at or near 100% utilization.
	Paging file is too small. MSCS may view the size deficiency as a node failure and cause a failover event.	Check the size of the Windows NT paging file.

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Table 6-1
Solving Installation Problems *continued*

Problem	Possible Cause	Action
MSCS installation will not complete on the first node.	Insufficient space on nonshared drives for MSCS.	Ensure there is enough free disk space for the MSCS installation files.
	Operating system is incorrect or deficient.	Ensure Windows NT 4.0 and appropriate service pack are installed.
	Hardware does not support clustering.	Ensure the hardware supports clustering. Run Compaq Cluster Verification Utility (CCVU) to verify that the hardware supports clustering.
	Primary IP address is invalid.	Verify that the addresses are valid. If DHCP is used to obtain noncluster IP addresses, run IPConfig.exe to ensure the network adapter cards have valid IP addresses. If the second IP address listed is 0.0.0.0, your primary address is invalid.
The physical disk resource(s) cannot be brought online.	Cluster nodes need to be rebooted.	Reboot cluster nodes after installing MSCS.
	Hardware errors or communications transport problems.	Use Event Viewer to verify no hardware errors or transport problems exist. Check the event log for disk I/O error messages or indications of problems with the communications transport.
	You may not have waited long enough to view the most up-to-date data. Cluster Administrator takes a snapshot of the registry when it starts up.	Wait a minute, then click Refresh (**F5**)

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Table 6-1
Solving Installation Problems *continued*

Problem	Possible Cause	Action
Clients do not see the cluster.	Clients can only view the virtual servers.	Clients do not see the cluster itself, only the virtual servers located in the cluster. If you have a virtual server defined, verify that the clients can see the virtual server.
Added logical drives are not recognized	Windows NT and Redundancy Manager do not support hot-add of logical drives.	Follow the steps below to add logical drives. 1. Uninstall MSCS. 2. Add drives in Disk Administrator. 3. Reinstall MSCS.
Redundancy Manager appears to function properly but does not recognize component failover.	Cluster may be improperly cabled.	Refer to the *Compaq ProLiant Cluster HA/F200 Poster* for proper cabling of the cluster.

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Troubleshooting Node-to-Node Problems

This section describes problems that may be encountered during server-to-server communication.

Table 6-2
Solving Node-to-Node Problems

Problem	Possible Cause	Action
The resources failed over but the nodes do not see each other.	No connectivity between the nodes.	1. Run Control Panel service applet on both nodes and verify the RPC service is running. 2. Use a network analyzer (such as Network Monitor), or RPCPing (available on the Microsoft Exchange Server CD) to ensure RPC connectivity exists on both nodes.
Node failover is not recognized by Redundancy Manager.	Cluster may be improperly cabled.	Refer to the *Compaq ProLiant Cluster HA/F200 Installation Poster* for proper cabling of the cluster.

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Table 6-2
Solving Node-to-Node Problems *continued*

Problem	Possible Cause	Action
The second node cannot join the cluster.	Improper name resolution.	1. Data in the WINS or DNS server may be incorrect for the second node. 2. Ensure the proper cluster name, node name, or IP address is used. 3. Verify Cluster Name resource has started.
	Cluster Service is not running.	Verify Cluster Service is running on the first node before attempting to join the second node.
	No network connectivity exists.	Check network connectivity.
	TCP/IP is not configured properly.	Verify TCP/IP configuration on both nodes.
	No IP connectivity.	Verify IP connectivity to the cluster address. It unable to ping the IP address ot the cluster, run Cluster Administrator on the first node. Ensure the cluster IP address resource is running.
	Primary IP address is invalid.	1. Check the cluster IP address resource properties. Ensure the cluster has a valid IP address and subnet mask. Ensure IP address does not conflict with an existing IP address on the network. 2. Verify addresses are valid. If DHCP is used to obtain noncluster IP addresses, run IPContig.exe to ensure the network adapter cards have valid IP addresses. If the second IP address listed is 0.0.0.0, your primary address is invalid.

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Shared Storage

This section addresses problems encountered using the Compaq StorageWorks RAID Array 4000 storage system as a shared storage device. This section does not address RA4000 storage system problems specific to the storage system itself or to using the storage system in a stand-alone server configuration. For those issues, see the *Compaq RA4000 Storage System User Guide*.

Table 6-3
Solving Shared Storage Problems

Problem	Possible Cause	Action
Drive(s) in the Compaq StorageWorks RAID Array 4000 are not recognized.	You may not have waited long enough to view the most up-to-date data. Cluster Administrator takes a snapshot of the registry when it starts up.	Wait a minute, then click Refresh (**F5**).
	Cluster nodes need to be rebooted.	Reboot cluster nodes after installing MSCS. Ensure the drives are recognized.
	Host bus adapter driver is not installed.	Ensure the host bus adapter driver for Windows NT is installed and running on both servers. If it is not installed, see the "Installing Drivers for Windows NT" chapter in the *Compaq StorageWorks Fibre Channel Host Adapter Installation Guide*.
Drive(s) in the Compaq StorageWorks RAID Array 4000 are not recognized.	Hardware errors or communications transport problems.	Use Event Viewer to verify no hardware errors or transport problems exist. Check the event log for disk I/O error messages or indications ot problems with the communications transport.
	Compaq ProLiant Clusters do not support the physical SCSI disks.	Use Event Viewer to verify no hardware errors or transport problems exist. Check the event log for disk I/O error messages or indications ot problems with the communications transport.

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Table 6-3
Solving Shared Storage Problems *continued*

Problem	Possible Cause	Action
Drive(s) in the Compaq StorageWorks RAID Array 4000 are not recognized.	Possible drive configuration problems.	1. Run the Compaq Array Configuration Utility online. This utility can be run online if at least one logical drive is configured and recognized. 2. Run the Compaq Array Configuration Utility offline. Shut down the server(s) and reboot with either the SmartStart CD or with diskette number 1 of the Array Configuration Utility. 3. If all drives are not recognized by the Array Configuration Utility, verify all Gigabit Interface Converter-Shortwave (GBIC-SW) modules are properly seated. 4. Verify all Fibre Channel cables are properly connected to the GBIC-SW modules. For details on how to connect the GBIC-SW modules and fibre cables, see the *Compaq RA4000 Storage System User Guide*. 5. When all drives are recognized and configured correctly, run Disk Administrator. 6. Verify all drive volumes appear in Disk Administrator and that each has a permanent drive letter assigned. 7. Verify the drive letter assignments on the second cluster node match the assignments on the first cluster node.

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Table 6-3
Solving Shared Storage Problems *continued*

Problem	Possible Cause	Action
Data on shared storage appears to be overwritten.	MSCS may not be loaded and therefore cannot manage access to drive volumes in the shared storage.	1. Ensure MSCS is loaded on both cluster nodes. 2. Using the Control Panel Service applet on each node, verify the cluster service is running.
The second node cannot connect to the shared drives.	Physical connection from the second node to the Compaq StorageWorks Fibre Channel Storage Hub does not exist.	1. Verify all Fibre Channel cables are properly connected to the GBIC-SW modules. For details on how to connect the GBIC-SW modules and the Fibre cables, see the *Compaq RA4000 Storage System User Guide.* 2. Verify that all Fibre Channel cables are properly connected to their GBIC-SW modules.
	Shared RA4000 drives are not assigned the same drive letters on both nodes.	Run Windows NT Disk Administrator on each node to verify all shared drives are assigned identical, permanent drive letters.
	The second node was powered on before the storage hub or the RA4000.	Shut down the second node, turn it off, then turn it on.

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Table 6-3
Solving Shared Storage Problems *continued*

Problem	Possible Cause	Action
Compaq Redundancy Manager shows cluster in nonredundant mode.	You are using ACU to expand capacity.	The firmware will automatically put the RA4000 in nonredundant mode during capacity expansion. This is normal behavior.
	ICL has failed.	Check Windows NT Event Log to determine it the ICL (interconnect link) to has failed.
	Mismatched firmware on the array controllers.	1. Check to make sure the firmware version levels match. 2. If they do not match, use Options ROMPaq to update the firmware.
Drive rebuild automatically restarts.	Failover may have occurred.	Check to see if a failover has occurred. It is normal behavior for a drive rebuild to restart it a failover has occurred.
Storage performance is marginal.	Cache modules on the array controllers do not match.	Obtain and replace cache module so that cache levels match on both array controllers.
Windows NT Event Log states: The Host Bus Adapter in slot %1 has averaged more than %2 Elastic Store Errors over the five seconds. The loop has become unstable. The adapter has been taken offline.	GBIC-SW laser has malfunctioned.	1. Manually fail over resources. 2. Refer to the *Compaq StorageWorks RAID Array 4000 User Guide's* "Replacing GBICs" chapter for instructions on replacing a GBIC-SW. 3. Manually fail back resources.

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Table 6-3
Solving Shared Storage Problems *continued*

Problem	Possible Cause	Action
Windows NT Event Log states: The Host Bus Adapter in slot %1 has averaged more than %2 Soft PCI Errors over the last five seconds. The loop has become unstable. The adapter has been taken offline.	GBIC-SW laser has malfunctioned.	1. Manually fail over resources. 2. Refer to the *Compaq StorageWorks RAID Array 4000 User Guide's* "Replacing GBICs" chapter for instructions on replacing a GBIC-SW. 3. Manually fail back resources.
Windows NT Event Log states: The Host Bus Adapter in slot %1 has averaged more than %2 Reset Login Primitives over the last five seconds. The loop has become unstable. The adapter has been taken offline.	GBIC-SW laser has malfunctioned.	1. Manually fail over resources. 2. Refer to the *Compaq StorageWorks RAID Array 4000 User Guide's* "Replacing GBICs" chapter for instructions on replacing a GBIC-SW. 3. Manually fail back resources.

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Client-to-Cluster Connectivity

This section addresses problems that may be encountered in cluster-to-LAN communication.

NOTE: The cluster is assigned one or more Net BIOS names associated with an IP address. Network clients communicate with the cluster through TCP/IP.

Table 6-4
Solving Client-to-Cluster Connectivity Problems

Problem	Possible Cause	Action
Clients do not see the cluster.	TCP/IP is not configured properly.	Verify that TCP/IP is configured on all network clients and on the cluster nodes.
	Clients can only view the virtual servers.	Clients do not see the cluster itself, only the virtual servers located in the cluster. If you have a virtual server defined, verify that the clients can see the virtual server.
	Clients may not be running the correct operating system.	Verify client is running Windows NT 4.0 and the latest Service Pack.

Continued

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Table 6-4
Solving Client-to-Cluster Connectivity Problems *continued*

Problem	Possible Cause	Action
Clients do not see virtual servers.	Virtual servers may not have their own IP addresses or Network Name resources.	Use Cluster Administrator to verify that both resources are online.
	Client protocol problem.	1. Verify client is accessing the cluster using the correct cluster network name or IP address. 2. Verify client has TCP/IP protocol correctly installed and configured.
	Resource name resolution problem may exist.	Use NetBT cache (Nbtstat.exe on the Windows NT CD) to determine whether the name had been previously resolved.
	Improper WINS configuration.	Confirm proper WINS configuration at the client using the WINS administrator. If WINS is not used, the *hosts* or *lmhosts* file will contain entries for each virtual server's network name and IP address.
	IP address problem if the client is accessing the resource through a specific IP address.	Ping the IP address of the cluster resource and cluster nodes from a DOS command prompt.

Continued

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Table 6-4
Solving Client-to-Cluster Connectivity Problems *continued*

Problem	Possible Cause	Action
Clients cannot access resources on a cluster node.	The corporate LAN Ethernet card has failed, but the private interconnect (cluster communication) continues to operate. The clients no longer have access to their primary cluster node and are failed over to the secondary cluster node. The applications in use by the clients remain on the primary cluster node because the private interconnect is still operating, precluding a failover ot the applications.	1. Manually fail over each ot the applications from the primary server to the secondary server. Make sure automatic failback is disabled, to prevent the application trom failing back to the inaccessible primary server. 2. Implement a redundant interconnect/LAN strategy. Install three PCI network cards per server. Set up one as a private interconnect configured for cluster communication only. Set up the other cards for client access (the LAN) and tor cluster communication. Configure the LAN network cards using Compaq's Advanced Network Fault Detection and Correction teature. Configured in this way, the private interconnect has two backups and the primary LAN network card has a backup as well.
Clients cannot access cluster resources.	WINS- or DNS-related.	1. Verify that the client machines are configured with WINS. 2. Verity that the cluster nodes are configured with either WINS or DNS. 3. If DNS is used tor the cluster nodes, make sure a DNS address record tor the cluster exists in the DNS database, particularly if the client is on a different subnet than the cluster.

Continued

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Table 6-4
Solving Client-to-Cluster Connectivity Problems *continued*

Problem	Possible Cause	Action
Clients cannot access a group that has failed over.	Networking problem.	1. Ensure a physical connection between the clustered nodes exists. 2. Verify the network cabling is not damaged or loose on the surviving node 3. Verify MSCS was able to receive the heartbeat ot the surviving node and properly failed over the resources. 4. Verify the failed over group is a virtual server (that is, the group contains an IP address as a resource). 5. If a hub joins the clients to the cluster, check the physical connection between the clients and the hub and between the hub and both cluster nodes.

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Cluster Groups and Cluster Resource

Microsoft Cluster Administrator solves many group and cluster resource problems. For troubleshooting tips on this topic, refer to the *Microsoft Cluster Server Administrator's Guide* and Cluster Administrator's Online Help.

Table 6-5
Solving Other Problems

Problem	Possible Cause	Action
An application starts but cannot be closed.	Cluster Administrator must be used to take applications offline.	Use Cluster Administrator to take the application offline. Do not close or exit an application from the application interface.
A resource hangs when taken offline.	Some resources take time to go offline.	Wait several minutes, then check any dependencies the resource may have. Verify that each can be taken offline.
An IP address added to a cluster group fails.	IP address configuration may be incorrect.	1. IP addresses must be different from every other IP address resource and from every other IP address on the network. 2. The IP address must either by reserved by the network administrator or statically assigned outside of a DHCP scope.
A resource fails over but does not fail back.	Groups may be configured to fail back manually or the automatic failback may be scheduled to occur during a specific time frame.	1. If expecting an automatic failback, verify the group is not set for a manual failback. 2. If expecting an immediate automatic failback, verify the group is not configured to fail back only during a user-defined timeframe.

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Troubleshooting Compaq Redundancy Manager

The following section addresses events, warning messages, and error messages you may receive from Redundancy Manager.

Event Logging

Redundancy Manager displays messages warning of possible changes and events to the system. When a message is displayed, click on Help to receive more details about that particular message.

The Event Viewer for Microsoft Windows NT Server displays additional information. For more information on using the Windows NT Event Viewer, refer to your Microsoft Windows NT Server documentation.

Informational Messages

This section provides a list of informational messages and actions to take using Redundancy Manager.

Table 6-6
Compaq Redundancy Manager Informational Messages

Message	Description	Action
Another instance has locked the loop. This instance is running in Read Only mode.	Another application has issued a lock management command to an array controller. The lock management command only allows viewing of the data.	No action needed to view the data.
The lock could not be set.	The array controller board is in an unknown state that has caused a failed connection to the array controller.	No action needed to view the data.

Continued

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Table 6-6
Compaq Redundancy Manager Informational Messages *continued*

Message	Description	Action
The loop has been locked by another application.	Another application has issued a lock management command to an array controller. The lock management command only allows viewing of the data.	No action needed to view the data.
Another program has a lock on the array controller(s). This program is either still running or has exited improperly. It is recommended that Redundancy Manager not be run while another program has a lock on the array controller(s). To stop this instance from starting, select the Cancel button. To start this instance select the Start button.	Another program has issued a lock management command to an array controller. The lock management command only allows viewing of the data.	No action needed to view the data.
This RA4000 is in Active/Standby mode. All logical disks in this array must have the same path assignments. Are you sure you want to continue?	A request has been made to change the status of a path in an Active/Standby configuration.	Proceed or click **Cancel**.

continued

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Table 6-6
Compaq Redundancy Manager Informational Messages *continued*

Message	Description	Action
You have not selected all the Paths to the following logical disk(s):	The logical disk or drives shown are claimed but not all possible paths were assigned.	Click **OK** for the Redundancy Manager to automatically assign the paths for this logical disk; Or, click **Cancel** to assign the paths manually.
You have not selected an Active Path to <xxxxxx>.	A logical disk is claimed but no Active Path is selected.	Click **OK** for the Redundancy Manager to automatically assign the path for this logical disk; Or, click **Cancel** to assign the path manually.
You have not selected any Paths to <xxxxxx>.	A logical disk is claimed but no paths are assigned.	Click **OK** for the Redundancy Manager to automatically assign the paths for this logical disk; Or, click **Cancel** to assign the paths manually.
You have not selected a Standby Path to <xxxxxx>.	A logical disk is claimed but no Standby Path is assigned.	Click **OK** for the Redundancy Manager to automatically assign the path for this logical disk; Or, click **Cancel** to assign the path manually.

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Warning Message

This section provides a warning message and actions to take using Redundancy Manager.

Table 6-7
Warning Message

Message	Description	Action
The previous lock by another application has expired. Do you want to override the lock and take control of the loop?	The previous lock on an array controller has expired.	No action needed to view the data; Or, override and take control of the array controller.

Error Messages

This section provides a list of error messages and actions to take using Redundancy Manager.

Table 6-8
Error Messages

Message	Description	Action
Another instance has locked the loop. This instance is running in Read Only mode.	Another application has issued a lock management command to an array controller. The lock management command only allows viewing of the data.	No action needed to view the data. To configure the data, close the other application to unlock the array controller. If the lock has expired, Redundancy Manager allows overriding the lock and taking control of the array controller.
Could not load resource DLL.	The file containing the configuration utility resources could not be loaded.	Reload Redundancy Manager from the CD.

continued

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Table 6-8
Error Messages *continued*

Message	Description	Action
Logical disk could not be reached in the following RA4000: <xxxxxx>.	Redundancy Manager found an array with no drives in it. This could be caused by a damaged array or a bad connection.	Check the array and all connections.
The lock could not be set.	The array controller board is in an unknown state that caused a failed connection to the array controller.	No action needed to view the data. To configure the data, check the array controller and all physical connections.
The loop has been locked by another application. Redundancy Manager is running in Read Only mode.	Another application has issued a lock management command to an array controller. The lock management command only allows viewing the data.	No action needed to view the data. To configure the data, close the other application to unlock the array controller. If the lock has expired, Redundancy Manager allows overriding the lock and taking control of the array controller.
There was an error attempting to shut down Windows NT. Please close all applications and shut down now.	An error occurred while shutting down Windows NT.	Close all applications and shut down the computer immediately.
A version of the Compaq Fibre Channel Host Adapter SCSI Miniport Driver (cpqfcalm.sys) is being used that does not support redundancy. The minimum version for redundancy support is VX.X. The current version is VX.Z. Redundancy has been disabled.	This message informs you that the version of cpqfcalm.sys doesn't support redundancy.	Make sure you have the correct version of cpqfcalm.sys.

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Other Potential Problems

Redundancy Manager displays text messages warning of possible changes and events to the system. When a message is displayed, click on Help to receive more details about that particular message.

Table 6-9
Troubleshooting Redundancy Manager Problems

Message	Description	Action
Could not find the resource DLL file.	The resource DLL file has been corrupted or is missing.	Reload the Redundancy Manager software from the CD.
Intercontroller Link Failure.	This indicates a hardware problem.	Replace the RA4000 backplane or add a new array controller.
Illegal Drives.	You are using the Micropolis 4/9-Gig drives. The firmware cannot resolve two array controllers talking to the drive.	Replace the drives.
Array controller firmware versions don't match.	The array controllers have different firmware versions.	Run the Options ROMPaq to update the firmware to the most current version.
Array controller hardware is not the same.	The array controller models are different.	Make both array controllers the same model.
Both array controllers don't see all the drives.	The backplane in the RA4000 may be faulty.	Repair or replace the backplane.
Expand operation in is progress.	The cache is not mirrored during this operation.	Wait until the expand operation is compete.

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Appendix A

Cluster Configuration Worksheets

Overview

This appendix contains blank worksheets you can use to design, configure, and install your Compaq ProLiant Cluster HA/F100 or HA/F200. Completed worksheets are illustrated in chapters 2 and 3 of this guide. Copy these worksheets and use as many as necessary to assist you in planning and designing your cluster configuration.

The following worksheets are included in this chapter:

- Cluster Group Definition worksheet
- Shared Storage Capacity worksheet
- Group Failover/Failback Policy worksheet
- Preinstallation worksheet

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Cluster Group Definition Worksheet

Complete the Cluster Group Definition worksheet for each business function requiring clustering.

Cluster Group Definition Worksheet				
Cluster Function				
Group #1				
Group #2				
Resource Definitions				
Group #1				
Resource #1				
	Sub Resource 1	Sub Resource 2	Sub Resource 3	Sub Resource 4
Resource #2				
	Sub Resource 1	Sub Resource 2	Sub Resource 3	Sub Resource 4
Resource #3				
	Sub Resource 1	Sub Resource 2	Sub Resource 3	Sub Resource 4
Resource #4				
	Sub Resource 1	Sub Resource 2	Sub Resource 3	Sub Resource 4
Group #2				
Resource #1				
	Sub Resource 1	Sub Resource 2	Sub Resource 3	Sub Resource 4
Resource #2				
	Sub Resource 1	Sub Resource 2	Sub Resource 3	Sub Resource 4
Resource #3				
	Sub Resource 1	Sub Resource 2	Sub Resource 3	Sub Resource 4
Resource #4				
	Sub Resource 1	Sub Resource 2	Sub Resource 3	Sub Resource 4

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Shared Storage Capacity Worksheet

Use the Shared Storage Capacity worksheet to outline your shared storage capacity requirements.

Shared Storage Capacity Worksheet		
	Disk Resource 1	**Disk Resource 2**
Description		
Required Capacity without RAID		
Level of Protection Desired		
RAID Configuration		
Required Capacity with RAID		
	Disk Resource 3	**Disk Resource 4**
Description		
Required Capacity without RAID		
Level of Protection Desired		
RAID Configuration		
Required Capacity with RAID		
	Disk Resource 5	**Disk Resource 6**
Description		
Required Capacity without RAID		
Level of Protection Desired		
RAID Configuration		
Required Capacity with RAID		

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Group Failover/Failback Policy Worksheet

Use the Group Failover/Failback Policy worksheet to define failover and failback settings for each cluster group.

<table>
<tr><th colspan="4">Group Failover/Failback Policy Worksheet</th></tr>
<tr><td>Group Name</td><td colspan="3"></td></tr>
<tr><th colspan="4">General Properties</th></tr>
<tr><td>Name</td><td colspan="3"></td></tr>
<tr><td>Description</td><td colspan="3"></td></tr>
<tr><td>Preferred Owners</td><td colspan="3"></td></tr>
<tr><th colspan="4">Failover Properties</th></tr>
<tr><td>Threshold</td><td colspan="3"></td></tr>
<tr><td>Period</td><td colspan="3"></td></tr>
<tr><th colspan="4">Failback Properties</th></tr>
<tr><td rowspan="3">☐ Prevent</td><td colspan="3">☐ Allow</td></tr>
<tr><td colspan="3">Choose one:</td></tr>
<tr><td>☐ Immediately</td><td>☐ Between hours</td><td></td></tr>
<tr><td></td><td>Start</td><td>End</td></tr>
</table>

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Preinstallation Worksheet

Use the preinstallation worksheet to gather information necessary for the installation of Compaq ProLiant Clusters HA/F100 or HA/F200.

Preinstallation Worksheet		
Are you:	❒ Forming a cluster *or* ❒ Joining a cluster	
Cluster Name:		
Domain account Microsoft Cluster Server will run under:	User Name:_____ Password:_____ Domain:_____	
Network Adapter Cards that will be used for client access to the cluster and for the private interconnect between the cluster nodes:		
Adapter Name	**IP Address**	**Use**
Address to Administer the cluster:	IP Address:_____ Subnet Mask:_____	
Controllers to be managed by Compaq ProLiant Cluster:		
Controller	**Slot Number**	
Partition used to store permanent cluster files:		

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Appendix B

Using Compaq Redundancy Manager in a Single-Server Environment

Overview

Compaq Redundancy Manager (Fibre Channel) is software designed to increase the availability of single-server or clustered systems using a Compaq StorageWorks RAID Array 4000 storage system (formerly Compaq Fibre Channel storage system). Redundancy Manager detects failures of the Compaq StorageWorks Fibre Channel Host Adapter (host bus adapter), Compaq StorageWorks RA4000 Controller (array controller), and Fibre Channel cable paths, and then reroutes the I/O processing. Redundancy Manager is a monitoring tool; it is not a real-time management tool.

In a nonclustered environment, Redundancy Manager enables full utilization of the redundant hardware available for use with RA4000 storage systems. For example, a single server may be configured with multiple host bus adapters, and it may be connected to dual RA4000s containing redundant storage array controllers and two Compaq StorageWorks Fibre Channel Storage Hubs.

IMPORTANT: Cable your Compaq ProLiant single-server system according to Compaq-recommended guidelines. Redundancy Manager may appear to work if the system is cabled differently, but it will not function in failover mode correctly

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Figure B-1 shows a single-server setup with an RA4000. This setup provides redundant paths to the RA4000.

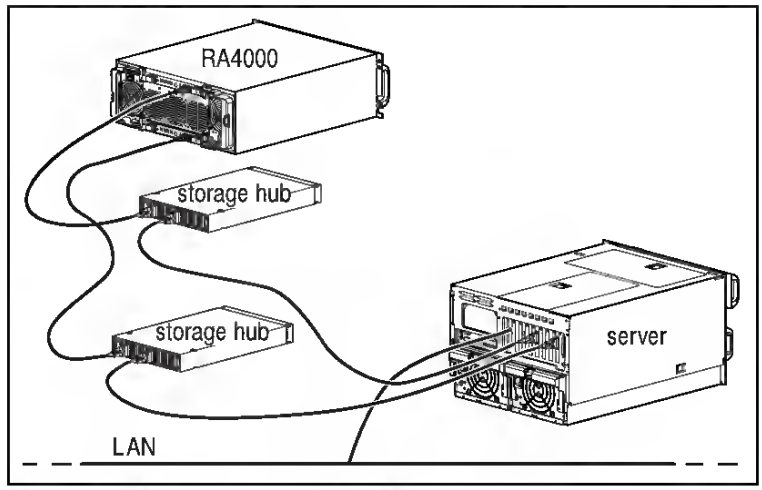

Figure B-1. Single-server setup with a single RA4000

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Figure B-2 shows a single-server setup with dual RA4000s. This setup provides redundant paths and I/O load balancing capability.

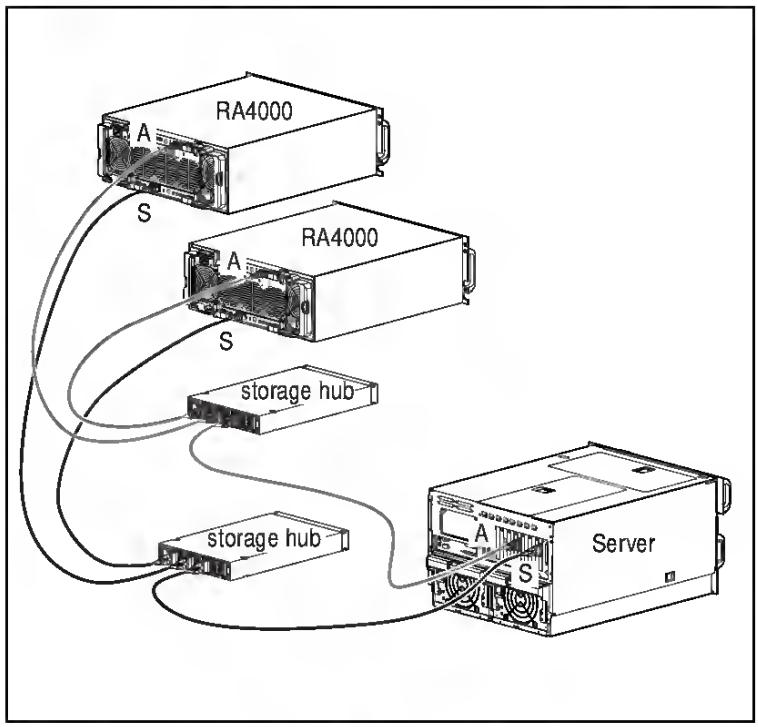

Figure B-2. Single-server setup with dual RA4000s

Redundancy Manager can be configured with multiple paths to a particular storage device. Each path can be defined as an active path, enabling static I/O load balancing, or with one active and one or more standby paths for failover. The Compaq Redundancy Manager graphical user interface (GUI) enables sophisticated system configuration and control of each defined path.

Redundancy Manager is supported on all Compaq ProLiant servers in single-server configurations.

The following sections provide information about:

- Installing Redundancy Manager
- Managing Redundancy Manager
- Troubleshooting Redundancy Manager

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Installing Redundancy Manager

The following requirements must be met to install Redundancy Manager on a server running Microsoft Windows NT Server 4.0/Enterprise Edition or Microsoft Windows NT Server 4.0:

- 32 MB of RAM required, 48 MB of RAM recommended for Windows NT Server 4.0/ Enterprise Edition or Microsoft Windows NT Server 4.0
- 1.5 MB reserved disk space
- VGA color or better
- At least two Compaq StorageWorks Fibre Channel Host Adapters per server
- At least two Compaq StorageWorks RA4000 Controllers per RA4000
- At least two Compaq StorageWorks Fibre Channel Storage Hubs
- Compaq SmartStart 4.30 or later
- Software Support Diskette 2.13 or later

IMPORTANT: The Software Support Diskette must be loaded before installing Redundancy Manager.

Automatically Installing Redundancy Manager

Follow these steps to automatically install Redundancy Manager:

1. Place the Redundancy Manager CD into the CD-ROM drive. It automatically loads the Install program.
2. Follow the instructions offered by the Redundancy Manager installation screens.
3. Remove the Redundancy Manager CD from the CD-ROM drive.
4. Reboot the server.

Redundancy Manager is now installed on your computer. To use Redundancy Manager, double-click on the icon.

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Manually Installing Redundancy Manager

If the server is not set up to automatically load when the CD is placed in the CD-ROM drive, follow these steps to manually install Compaq Redundancy Manager:

1. Place the Compaq Redundancy Manager (Fibre Channel) CD in the CD-ROM drive.
2. Select Settings from the Start menu.
3. Select Control Panel from the Settings menu.
4. Select Add/Remove Programs from the Control Panel.
5. Press Install from the Add/Remove Programs page.
6. Press Next from the Add/Remove Programs page.
7. Press Browse from the Add/Remove Programs page.
8. Locate the Redundancy Manager *SETUP.EXE* file on the Redundancy Manager CD.
9. Click Finish from the Add/Remove Programs page. The setup program begins.
10. Follow the instructions displayed on the Redundancy Manager installation screens.
11. Close the Control Panel.
12. Remove the Redundancy Manager CD from the CD-ROM drive.
13. Reboot the server.

Redundancy Manager is now installed on your computer. To use Redundancy Manager, double-click the icon.

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Managing Redundancy Manager

Redundancy Manager increases the availability of single-server or clustered systems using the RA4000 storage system. Redundancy Manager can detect failures of the host bus adapters, array controllers, and Fibre Channel data paths. It then reroutes the I/O processing.

This section explains how to use Redundancy Manager to change and set active and standby paths.

Figure B-3 shows the Main Screen for Redundancy Manager.

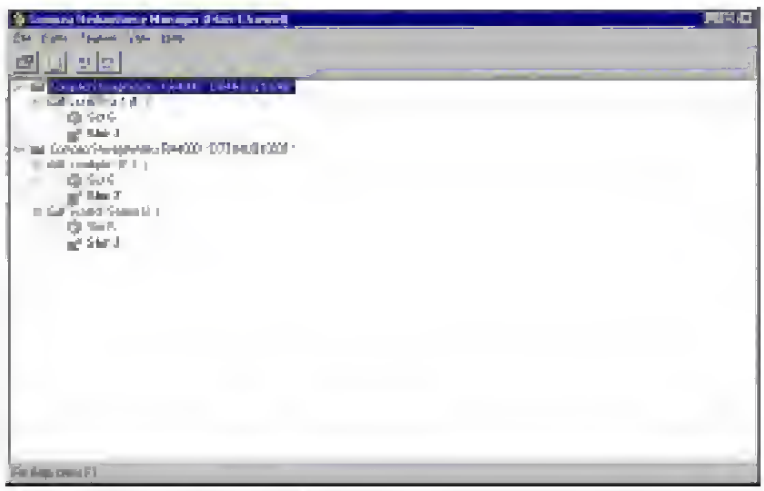

Figure B-3. Example of the main screen

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Changing Paths

The following information describes how to change paths using Redundancy Manager.

> **NOTE:** Redundancy Manager will not change the configuration until you close the Redundancy Manager program or select Apply Changes. The Main Screen may not show the current system configuration. Use Refresh (**F5**) to see the current configuration.

Changing from Standby to Active Paths

To change a path from Standby to Active mode:

1. Highlight the Standby path you want to change.
2. Select Path from the main screen menu bar.
3. Select Set As Active from the Path menu.

The selected Standby path will change to Active when you select Apply Changes or close Redundancy Manager.

Shortcut method

Following is a shortcut method to change a path from Standby to Active:

1. Highlight the Standby path you want to change.
2. Click the right mouse button to display a pop-up menu.
3. Select Set As Active from the menu.

The selected Standby path will change to Active when you select Apply Changes or close Redundancy Manager.

Changing from Active to Standby Paths

To change a path from Active to Standby mode:

1. Highlight the Active path you want to change.
2. Select Path from the main screen menu bar.
3. Select Set As Standby from the Path menu.

The selected Active path will change to Standby when you select Apply Changes or close Redundancy Manager.

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Shortcut method

Following is a shortcut method to change a path from Active to Standby:

1. Highlight the Active path you want to change.
2. Click the right mouse button to display a pop-up menu.
3. Select Set As Standby from the menu.

The selected Active path will change to Standby when you select Apply Changes or close Redundancy Manager.

Expanding Capacity

Redundancy Manager does not support the hot-add of logical drives. To add drives, you must:

1. Physically add the drives to the RA4000.
2. Reboot Windows NT on the server to see the new drives. Shut down and reboot the server.
3. Run the Array Configuration Utility to configure the drives.

   NOTE: You cannot increase the capacity of an existing Windows NT drive volume, but you can assign a new drive letter to the extra capacity furnished by the added drives.

4. Run Windows NT Disk Administrator to assign a drive letter to the newly created, unused capacity of your RAID volume.
5. While still running Disk Administrator, format the drives using Microsoft NTFS.
6. Run Redundancy Manager.

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Other Functions

Two helpful functions for using the Redundancy Manager GUI are Refresh and Rescan.

Refresh

Refresh (**F5**) updates information on the GUI screen and checks for path failures and path changes, and displays the current configuration. The GUI will not update automatically. The changes that you have made will not be saved. Use Refresh to update the main screen to see the current configuration or to see if a failure has happened in the system. Refresh does not affect any processing or interrupt any of the system's functions.

Rescan

Rescan is used to check for new host bus adapters and array controllers and after adding and removing physical drives. Use rescan after a hot-swap of host bus adapters or array controllers and after adding or removing physical drives. Follow these steps to run Rescan:

NOTE: For every hot replace, a rescan should be run on each machine.

1. Select Features from the Main screen.
2. Select Rescan from the Features menu.

NOTE: Reboot each server to clear the SCSI port after seven hot replaces.

Troubleshooting Redundancy Manager

This section provides information on the Redundancy Manager event logging in the following areas:

- Informational messages
- Warning messages
- Error messages
- Troubleshooting Redundancy Manager
- Potential problems

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Overview

Redundancy Manager displays messages to inform you of possible changes and events in the system. When a message is displayed, click on Help to receive more details about that particular message.

Redundancy Manager has three types of messages: informational, warning, and error. A green icon indicates an informational message; an amber icon indicates a warning message; and a red icon indicates an error message.

The Event Viewer for Microsoft Windows NT Server displays additional information. For further information on using the Windows NT Event Viewer, refer to your Microsoft Windows NT Server documentation.

Informational Messages

This section provides a list of the informational messages that Redundancy Manager may display and the action you can take. An informational message informs you of possible changes and events in the system.

Table B-1
Informational Messages

Message	Description	Action
Another instance has locked the loop. This instance is running in Read Only mode.	This message indicates that another application has issued a lock management command to an array controller. The lock management command only allows you to view the data.	No action needed to view the data.
The lock could not be set.	This message informs you that the array controller board is in an unknown state that caused a failed connection to the array controller.	No action needed to view the data.

continued

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Table B-1
Informational Messages *continued*

Message	Description	Action
The loop has been locked by another application.	This message indicates that another application has issued a lock management command to an array controller. The lock management command only allows you to view the data.	No action needed to view the data.
This RA4000 is in Active/Standby mode. All the Logical disks in this Array must have same path assignments. Are you sure you want to continue?	This message indicates that you have made a request to change the status of a path in an Active/Standby configuration.	Proceed or click **Cancel**.
You have not selected all the Paths to the following logical disk(s):	This message indicates that the logical disk or drives shown are claimed but you did not assign all possible paths.	Click **OK** for the Redundancy Manager to automatically assign the paths for this logical disk; Or, click **Cancel** to assign the paths yourself.
You have not selected an Active Path to <xxxxxx>.	This message indicates that you claimed a logical disk but did not select an Active Path.	Click **OK** for the Redundancy Manager to automatically assign the path for this logical disk; Or, click **Cancel** to assign the path yourself.
You have not selected any Paths to <xxxxxx>.	This message indicates that you claimed a logical disk but did not assign any paths.	Click **OK** for the Redundancy Manager to automatically assign the paths for this logical disk; Or, click **Cancel** to assign the paths yourself.
You have not selected a Standby Path to <xxxxxx>.	This message indicates that you claimed a logical disk but did not select a Standby path.	Click **OK** for the Redundancy Manager to automatically assign the path for this logical disk; Or, click **Cancel** to assign the path yourself.

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Warning Message

This section provides a list of the warning messages that Redundancy Manager may display and the action you can take. A warning message informs you of possible noncritical changes and events in the system.

Table B-2
Warning Message

Message	Description	Action
The previous lock by another application has expired. Do you want to override the lock and take control of the loop?	This message indicates that the previous lock on an array controller has expired.	No action needed to view the data. Override to take control of the array controller.

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Error Messages

This section provides a list of the error messages that Redundancy Manager may display and the action you should take. An error message informs you of possible critical changes and events in the system.

Table B-3
Error Messages

Message	Description	Action
Another instance has locked the loop. This instance is running in Read Only mode.	This message indicates that another application has issued a lock management command to an array controller. The lock management command only allows you to view the data.	No action needed to view the data. To configure the data, close the other application to unlock the array controller. If the lock has expired, Redundancy Manager allows you to override the lock and take control of the array controller.
Another program has a lock on the Array Controller(s). This program is either still running or has exited improperly. It is recommended that Compaq Redundancy Manager not be run while another program has a lock on the Array Controller(s). To stop this instance from starting, select the Cancel button. To start this instance select the Start button.	Another program has issued a lock management command to an array controller. The lock management command only allows viewing of the data.	No action needed to view the data.

continued

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Table B-3
Error Messages *continued*

Message	Description	Action
Could not load resource DLL.	This message signifies that the file containing the configuration utility resources could not be loaded.	Reload Redundancy Manager from the CD.
Logical disk could not be reached in the following RA4000: <xxxxxx>.	This message indicates that Redundancy Manager found an RA4000 with no drives in it. A damaged RA4000 or a bad connection could cause this.	Check the RA4000 and all connections.
The lock could not be set.	This message informs you that the array controller board is in an unknown state that caused a failed connection to the array controller.	No action needed to view the data. To configure the data, check the array controller and all physical connections.
The loop has been locked by another application. Redundancy Manager is running in Read Only mode.	This message informs you that another application has issued a lock management command to an array controller. The lock management command only allows you to view the data.	No action needed to view the data. To configure the data, close the other application to unlock the array controller. If the lock has expired, Redundancy Manager allows you to override the lock and take control of the array controller.
There was an error attempting to shut down Windows. Please close all applications and shut down now.	This message signifies that an error occurred while shutting down Windows.	Close all applications and shut down your computer immediately.
NT Event Log states: The Host Bus Adapter in slot %1 has averaged more than %2 Elastic Store Errors for the last five seconds. The loop has become unstable. The adapter has been taken offline.	GBIC laser has malfunctioned.	Refer to the *Compaq StorageWorks RAID Array 4000 User Guide*'s "Replacing GBICs" chapter for instructions about how to replace a GBIC.

continued

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Table B-3
Error Messages *continued*

Message	Description	Action
A version of the Compaq Fibre Channel Host Adapter SCSI Miniport Driver (cpqfcalm.sys) is being used that does not support redundancy. The minimum version for redundancy support is VX.X. The current version is VX.Z. Redundancy has been disabled.	This message informs you that the version of cpqfcalm.sys doesn't support redundancy.	You must make sure you have the correct version of cpqfcalm.sys.
NT Event Log states: The Host Bus Adapter in slot %1 has averaged more than %2 Soft PCI Errors for the last five seconds. The loop has become unstable. The adapter has been taken offline.	GBIC laser has malfunctioned.	Refer to the *Compaq StorageWorks RAID Array 4000 User Guide*'s "Replacing GBICs" chapter for instructions about how to replace a GBIC.
NT Event Log states: The Host Bus Adapter in slot %1 has averaged more than %2 Reset Login Primitives for the last five seconds. The loop has become unstable. The adapter has been taken offline.	GBIC laser has malfunctioned.	Refer to the *Compaq StorageWorks RAID Array 4000 User Guide*'s "Replacing GBICs" chapter for instructions about how to replace a GBIC.

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Troubleshooting Redundancy Manager

Troubleshooting Potential Problems

This section provides help for troubleshooting potential problems with the Redundancy Manager.

Table B-4
Troubleshooting Potential Problems

Message	Description	Action
Could not find the resource DLL file.	The error message "Could not load resource DLL" indicates that the resource DLL file has been corrupted or is missing.	Reload the Redundancy Manager software from the CD.
Intercontroller Link Failure.	This indicates a hardware problem.	Replace the RA4000 storage array backplane or add a new array controller.
Illegal Drives.	This indicates that you are using the Micropolis 4/9 Gig drives. The firmware can't handle two array controllers talking to the drive.	Replace the drives.
Array controller firmware versions don't match.	This indicates that the array controllers have different firmware versions.	Run the Options RomPaq to update the firmware to the most current version.
Array controller hardware is not the same.	This indicates that the array controller models are different.	Make both array controllers the same model.
Both array controllers don't see all the drives.	This indicates the possibility that the backplane in the RA4000 storage array is faulty.	Replace the backplane or have it repaired.
Expand operation in progress.	This indicates that the cache is not mirrored during this operation.	Wait until the expand is complete.

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Appendix C

Software and Firmware Versions

The following table lists supported software and firmware versions for the ProLiant Cluster HA/F100 and HA/F200.

IMPORTANT: Refer to the Compaq High Availability website (http://www.compaq.com/highavailability) for information about software and firmware updates recommended or required for your Compaq ProLiant Cluster.

Table C-1
Supported Software/Firmware Versions

Software/Firmware Title	Version
Compaq SmartStart and Support Software CD	4.10 or later (HA/F100) 4.30 or later (HA/F200)
Compaq Support Software Diskette for Windows NT (NT SSD)	2.12c or later (HA/F100) 2.13a or later (HA/F200)
Array controller firmware	2.40 or later
Options ROMPaq from Diskette Builder	2.52

continued

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Table C-1
Supported Software/Firmware Versions *continued*

Software/Firmware Title	Version
Compaq Redundancy Manager (Fibre Channel)	1.0 or later
Microsoft Windows NT Server 4.0 Service Pack	3 or later (HA/F100) 3, 4, 5 + QFE (HA/F200)
Compaq Cluster Verification Utility	1.5 or later (HA/F100) 2.0 or later (HA/F200)
Compaq Insight Manager	3.6 or later
Compaq Insight Manager XE	2.0 or later (optional)
Compaq Intelligent Cluster Administrator	1.5 or later (optional)

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Glossary

Active/active	A state in which each host bus adapter is processing data when the cluster is operating normally.
Active/standby	A state in which one host bus adapter is processing data and the other is in a booted, but inactive, state when the cluster is operating normally. The standby node does not execute its own clustered applications and has no cluster groups to fail over to the active node.
Arbitrated loop	A connection method in which two or more ports can be interconnected, but only two ports at a time can communicate.
Array controller	A hardware device that facilitates communications between a host and one or more devices organized on an array. Also called RA4000 controller.
Availability	A measure of how well a computer system can continuously deliver services to its clients. Availability is typically expressed as a percentage, with 100 percent being the best possible rating.
Blink LEDs	The ability to light the drive tray LEDs on a particular RA4000.
Business-critical	Applications that are key to business success but not significant enough to justify the high cost of a traditional clustering solution. Their failure causes lost revenue, decreased productivity, and customer dissatisfaction.
Cluster	A group of systems that work collectively as a single system to provide fast, uninterrupted computing service. Clustering is a way to increase availability, processing capacity, and I/O bandwidth.

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Cluster group	A collection of interdependent resources that logically represents a clustered client/server function. This is a user-definable entity used by Microsoft Cluster Server (MSCS) software.
Compaq StorageWorks RA4000 Controller	A hardware device that facilitates communications between a host and one or more devices organized on an RA4000.
Compaq StorageWorks Fibre Channel Host Bus Adapter	A device that provides an interface between a host system (server) and storage system or other devices connected on a fibre channel arbitrated loop or fabric.
Compaq StorageWorks RAID Array 4000	A storage device including disk drives and one or more resident array controllers.
Conflict	A misunderstood command sent by software that causes processing to halt.
Dynamic IP address assignment	An automatically assigned address that comes from an unused IP address pool. When the client/server session ends, the IP address is returned to the pool. The server can use fewer IP addresses to communicate with clients. Clients do not need to provide a hard-coded address to the server.
Ethernet	A standard network protocol that primarily operates on a physical level, using network interface cards and cabling to transmit data between computers. Transfer rates are normally 1,000 or 10,000 megabits per second.
Failback	The process of moving the operation of a previously failed cluster group from the secondary cluster node back to the primary node.
Failover	The process of moving the operation of a cluster group from the primary node to the secondary node in the same cluster.
Fault tolerance	A design concept that allows continued operation of a computer entity when a fault (or failure) is encountered. Tolerance is achieved primarily by designing redundant elements into the entity.

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Fibre Channel Array	*See* RA4000 (Compaq StorageWorks RAID Array 4000)
Fibre Channel	An IEEE standard for providing high-speed data transfer among workstations, mainframes, supercomputers, desktop computers, storage devices, and display devices.
Fibre Channel Host Adapter	*See* Compaq StorageWorks Fibre Channel Host Adapter. *See Also* host bus adapter.
Fibre Channel Host Controller	*See* Compaq StorageWorks Fibre Channel Host Adapter. *See Also* host bus adapter.
Fibre Channel array controller	*See* Compaq StorageWorks RA4000 array controller.
Heartbeat	A signal transmitted between cluster nodes to indicate each node's operating state.
High availability	A term used to identify a computer system that can continuously deliver services to its clients 99.9 percent of the time (no more than 8.5 hours of downtime per year).
Host	The central or controlling computer in a system of computers connected by communications links.
Host bus adapter	A card used to connect a peripheral to the host server. Also called host adapter.
Host bus adapter failover	The process of moving the operation of all I/O from one host bus adapter to another host bus adapter. This can be accomplished manually using Compaq Redundancy Manager or automatically upon failure of one of the adapters.
Hot pluggable	Computer components that can be removed and replaced without powering down the system.
Hot spare	A computer component that is powered on, not actively processing data, and awaiting a request to take over operation of failed component.
Interconnect	A physical connection between cluster nodes that transmits intracluster communication.

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IP address	Internet Protocol Address. A number that uniquely identifies a host (server) so that computer entities can locate and communicate with each other through the transfer of packets. IP addresses can be statically or dynamically assigned.
Load balancing	To balance the amount of work (processing) undertaken by each node in a cluster.
Logical disks	The available logical disks that Compaq Redundancy Manager can access displayed in a tree hierarchy format.
Mission-critical	Applications essential to business operations.
Network interface controller	A board that allows a computer to be connected with a network, and that works with the network operating system to control the flow of information over the network.
NIC	*See* Network Interface Controller
Node	An individual server in a cluster.
NTFS	Microsoft New Technology File System. A file organization system by which data is stored and accessed in a Windows NT operating system.
Paging file	A Windows NT paging file for virtual memory, called PAGEFILE.SYS. The paging file is not necessarily a single file; it can be a group of files stored in various locations, across hard disks and partitions.
POST	*See* Power-On Self-Test
Power-On Self-Test	A set of operations executed every time a system is turned on that verifies components are present and operating.
Preferred node	The principal server an application is configured to operate from.
Proprietary clustering system	Traditionally a large, highly scalable UNIX and mainframe system that is costly and challenging to set up and maintain. Used only in mission-critical applications that can afford no downtime.

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Quorum disk A device managed by Microsoft Cluster Server (MSCS) that provides a means for persistent storage of the cluster configuration information required for failover and failback events as well as for arbitrating ownership of cluster resources.

RA4000 *See* Compaq StorageWorks RAID Array 4000

RAID *See* Redundant Array of Inexpensive Disks

Redundant Array of Inexpensive Disks A method of using hard disk drives in an array to provide data redundancy to increase system reliability and performance. RAID is classified in the following levels:

- **RAID 0** Data striping. This RAID level stripes data across all drives of the array, but does not incorporate a method to create redundant data. RAID 0 does not provide fault tolerance.
- **RAID 1** Drive mirroring. This level creates fault tolerance by storing two sets of duplicate data on a pair of disk drives.
- **RAID 4** Data guarding. This level involves the use of a single, designated drive containing parity data. If a drive fails, the controller uses the data on the parity drive and the remaining drives to reconstruct data from the failed drive.
- **RAID 5** Distributed data guarding. This level stores parity data across all the drives in the array. Spreading the parity across all the drives allows more simultaneous read operations and higher performance than data guarding (RAID 4).

Redundancy The provision of multiple, interchangeable components to perform a single function in order to cope with failures and errors. A RAID set is considered to be redundant when user data is recorded directly to one member and all of the other members include associated parity information.

Reliability The continuous integrity of a system (server, storage, network, or cluster).

Rescan The ability to check for new or lost logical disks or an array controller on the loop.

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Resource	A software or hardware entity upon which a client/server application or service is dependent. As it pertains to Microsoft Cluster Server (MSCS), a cluster resource must have the ability to be managed by the cluster and must reside on one of the cluster nodes. A resource can be a member of only one group.
Scalability	The ability of a system (server, storage, network, or cluster) to grow or expand in performance or capacity.
SCSI	Small Computer Systems Interface. A standard parallel interface for rapid data transmission.
ServerNet	A bi-directional, high-bandwidth, low-latency, redundant path, network interconnect.
Service	A data set or operation set exported by application servers to their clients.
Shared resource	A type of cluster organization in which some resources are accessible to all systems in the cluster.
Static IP address assignment	A unique, nonchanging number assigned to computer entities that allows them to reliably communicate with each other.
System	A complete computer system capable of operating independently. A system can be either a single processor system or an SMP system. Example: a server.
UPS	Uninterruptible Power Supply.
Virtual server	A cluster group that has an IP address (and optional network name) as one of its resources. Network clients can connect directly to a virtual server, which appears to clients as an individual server.

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